

THE
PHILOSOPHICAL MAGAZINE:

COMPREHENDING
THE VARIOUS BRANCHES OF SCIENCE,
THE LIBERAL AND FINE ARTS,
AGRICULTURE, MANUFACTURES,
AND
COMMERCE.

BY ALEXANDER TILLOCH,
MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

“Nec araneorum fane textus ideo melior, quia ex se fila gignunt. Nec noster villior quia ex alienis libamus ut apes.” JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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CONTENTS

OF THE

THIRD VOLUME.

DESCRIPTION of the Volcano in the Island of St. Lucia. By M. CASSAN	Page 1
Account of the Method of Catching Wild Elephants at Tipura in the East Indies. By JOHN CORSE, Esq.	5, 130
On the Materials used for Manufacturing Cast Iron. By Mr. DAVID MUSHET, of the Clyde Iron Works	13
On Preserving Seeds of Plants in a State fit for Vegetation. By JOHN SNEYD, Esq. of Belmont, Staffordshire	30
A quick and easy Method of converting Weeds and other Ve- getable Matter into Manure. By Mr. BROWN, of Derby	32
Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth. By M. DE SAUSSURE	33, 147, 294
Analysis of the Spinel Ruby. By C. VAUQUELIN, Inspec- tor of Mines and Member of the French National Insti- tute	41
Description of a remarkable Spring of Fresh Water, which rises through the Water of the Sea. By the Abbé SPAL- LANZANI	49
Experiments respecting the Effects of Electricity on the Fer- mentation of Vegetable and the Corruption of Dead Animal Substances. By M. ACHARD	51
Observations and Experiments on Staining Wood. By Pro- fessor BECKMANN	54
Description of a new Diving Machine, proper for being em- ployed in Rivers, &c. By C. H. KLINGERT	59
Observations on Fire Balls. By F. C. FULDA	66
A Communication from Mr. W. H. PEPYS jun. Member of the London Philosophical Society, containing an Account of some interesting Experiments on the Production of Artificial Cold, in one of which Fifty-six Pounds of Mercury were frozen into a solid Mass	76
Letters from some of the Men of Science engaged in the French Expedition to Egypt	84

On

<i>On the new Insect so prejudicial to Apple Trees; and a Method of extirpating it</i>	- - -	Page 89, 224
<i>Second Communication from Dr. THORNTON, Physician to the General Dispensary, relative to different Trials made with Faëtitious Airs</i>	- - -	90
<i>Biographical Memoirs of JAMES BERNOULLI</i>	-	92
<i>Account of a remarkable Fiery Eruption from the Earth in Iceland, in the year 1783. By S. M. HOLM, S. S. Theol. Cand.</i>	- - -	113
<i>An Account of Toaldo's System respecting the Probability of a Change of Weather at the different Changes of the Moon</i>	-	120
<i>On the present State of Surgery in Turkey. By W. ETON, Esq.</i>	- - -	127
<i>Observations on the Bodily Conformation and Mental Capacity of Negroes. By Professor BLUMENBACH</i>	-	141
<i>Observations on the Winter Sleep of Animals and Plants. By Professor FABRICIUS</i>	- - -	156
<i>Experiments made to ascertain the Composition of the Swedish Stone Paper or Artificial Slate. By J. G. GEORGI</i>	-	158
<i>On the so called Sea Froth and other Substances of which the Bowls of the Turkish Pipes are made. By Dr. REINEGG</i>	-	165
<i>A singular Phenomenon respecting Snow, some of which, of a red Colour, was found on the Alps. By M. DE SAUSURE</i>	- - -	168
<i>Description of an Apparatus proposed to be applied to M. KLINGERT'S Diving Machine, to enable it to be used at greater Depths than it otherwise could</i>	-	171
<i>Singular Instance of the Attachment of Birds of Prey to their Young. By M. CRONSTEDT</i>	-	176
<i>A short View of the Mitchillian Theory of Fever, and of Contagious Diseases in general</i>	- - -	177
<i>Description of a Machine for drawing Bolts in and out of Ships. Invented by Capt. WILLIAM BOLTON of the Navy</i>	- - -	189
<i>Description and Use of C. GUYTON'S Eudiometer</i>	-	191
<i>On the Component Parts of Iron-stones, and how these in the manufacturing affect the Quality of Crude Iron. By Mr. DAVID MUSHET, of the Clyde Iron Works</i>	-	193, 239
<i>A remarkable Case of internal Pain in the Heel, and an incipient Mortification, cured by the Inhalation of Vital Air. By Dr. THORNTON</i>	- - -	213
<i>Observations on Living Animals found inclosed in Stones and other solid Substances. By F. W. A. MURHARD</i>	-	225
<i>Observations on Snow and Rain; their Influence on Vegetation, and their Combination with Oxygen. By J. H. HASENFRATZ</i>	- - -	233

CONTENTS.

v

<i>A short Account of Souffriere in the Island of St. Lucia. From Observations on the Diseases which appeared in the Army there in December 1778, &c. By Dr. ROLLO</i>	Page 256
<i>Extract of a Report, on the Means to be used for purifying the Air in the Apartments of Sick Persons, made to the Society of Medicine at Brussels. By J. B. VAN MONS</i>	- 258
<i>Simple and Easy Method of Cleaning and Whitening Prints or Engravings. By M. FABBRRONI</i>	- 260
<i>Observations on the British Trade with Turkey. By W. ETON, Esq.</i>	- 262
<i>Observations on Naples Yellow, and the different Methods of preparing it. By Professor BECKMANN</i>	- 278
<i>Comparison between the Human Race and that of Swine. By I. F. BLUMENBACH</i>	- 284
<i>Account of the Method of making Sugar from Beet Roots, lately discovered by M. ACHARD</i>	- 291
<i>Description of an Improved Machine for Cutting Chaff, invented by Mr. ROBERT SALMON</i>	- 292
<i>Fourth Communication from Dr. THORNTON, Physician to the General Dispensary, relative to Pneumatic Medicine</i>	299
<i>Account of the New Machine invented by the late Mr. CUSTANCE, for making Vegetable Cuttings for the Microscope. Communicated by Dr. THORNTON</i>	- 302
<i>Remarkable Instance of a Turkey Cock hatching Eggs. By M. OEDMANN</i>	- 309
<i>Method of securing Trees from the prejudicial Effects of Frost. By P. J. B. DI SANMARTINO</i>	- 310
<i>Report on the Travels of C. OLIVIER and C. BRUGUIERE, undertaken by order of the French Government, through the Ottoman Empire, Egypt and Persia, during the Years 1792, 93, 94, 95, 96 and 97. By C. OLIVIER</i>	- 337
<i>Process of making Attar, or Essential Oil of Roses. By Lieut. Col. POLIER</i>	- 347
<i>On Primary Ores of Iron. By Mr. DAVID MUSHET, of the Clyde Iron-works</i>	- 350
<i>Description of the Lacsha, or Lac Insect. By Mr. W. ROXBURGH, Surgeon on the Madras Establishment</i>	367
<i>Mayow anticipated: or, The Discoveries of HOOKE relative to the Composition of our Atmosphere. Communicated by Dr. THORNTON</i>	- 370
<i>On a New Kind of Sympathetic Ink. By M. MEYER</i>	375
<i>Description of M. DE SAUSSURE'S Diaphanometer. By Dr. F. W. AUG. MURHARD</i>	- 377
<i>History of Astronomy for the Year 1798. Read in the College de France, Nov. 20. By JEROME LALANDE</i>	381
A 2	Observations

<i>Observations and Experiments in regard to the Figures formed by Sand, &c. on Vibrating Surfaces.</i>	By J. G. VOIGT	-	-	-	Page 389
<i>Communication from Mr. CRUICKSHANK, Chemist to the Ordnance, relative to a Mistake in the last Edition of Dr. SMYTH's Treatise on the Effects of Nitrous Vapour in preventing and destroying Contagion. With an Account of the Methods now employed at Woolwich for fumigating with the Sulphurous Acid, and with Oxygenated Muriatic Acid Gas</i>	-	-	-	-	396
<i>Report made to the French National Institute, by C. GUYTON and DARCEY, in regard to the Results of the Experiments of C. CLOUET, on the different States of Iron, and the immediate Conversion of it into Cast Steel</i>	-	-	-	-	400
<i>Extract of a Report made by C. PICTET, of Geneva, to the Society for the Advancement of the Arts established in that City, in regard to the Steel-Yards of C. PAUL</i>	-	-	-	-	408
<i>A new, easy, and cheap Method of impregnating Water with Carbonic Acid Gas. Communicated by Dr. A. N. SCHERER</i>	-	-	-	-	416
<i>Fifth Communication from Dr. THORNTON, Physician to the General Dispensary, relative to Pneumatic Medicine</i>	-	-	-	-	418
<i>New Publications</i>	-	-	-	-	99, 319, 321, 323
<i>Intelligence and Miscellaneous Articles</i>	-	-	-	-	103, 216, 312, 419

THE
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FEBRUARY 1799.

I. *Description of the Volcano in the Island of St. Lucia.* By
M. CASSAN. From New Transactions of the Swedish
Academy of Sciences, Vol. XI.

MORE volcanoes are to be found in the West India islands than in any other part of the globe; and from the frequency of earthquakes, the abundance of hot springs, &c. in these islands, there is reason to conclude that those substances which are the cause of them still exist. On account of the great quantity of sulphur produced by the mountain where this crater is situated, the name of *la Souffriere* has been given to it and to the whole adjacent district. The mountain itself forms a part of a high ridge, which runs across the whole island from north-east to south-west, and encloses the crater like a basin, which can be reached without great difficulty. Those who visit it must put on thick-soled boots, as the earth, before they have got to the distance of two miles from the town, becomes exceedingly hot; and they must carry nothing of metal with them, and particularly silver, because their splendor is destroyed by the vapour. The sulphurised hydrogenous smell, which still increases,

begins at the distance of little more than half a mile from the town. But however strong this smell may be, it seems not to be prejudicial, for the inhabitants in the neighbourhood enjoy the best health and attain to a considerable age. Though this district is mountainous and exposed to inundations, it is very fruitful: its sugar canes produce the richest sugar, as the districts around Etna and Vesuvius produce the most celebrated wine. The nearer you approach the crater, the more numerous you find the volcanic productions. You pass over various rivulets, the water of which has a sulphureous smell, and the scum seems to contain saline and ochery matter. You soon after arrive at the side of the mountain which rises over the volcano towards the south-west. The road lies across the declivity of the mountain, which is exceedingly steep; so that the traveller on one side sees a terrible, almost perpendicular, abyss filled with abundance of vapour from boiling water by which he is surrounded, and as it were enveloped: on the other side he is enclosed by a high steep rock, yet one can ride without danger to that part of the mountain which encloses the volcano on the east side; but when you arrive there, you must procure a guide, and descend the mountain, by a very steep path, between low thick brush-wood. Throughout the whole way you must beat on both sides with a stick, in order to guard against being bit by snakes. Scarcely have you reached the bottom of the mountain when you find the heat of the atmosphere considerably increased, and the earth hot under the feet. The sulphureous vapours which here surround the body soon occasion an abundant perspiration, and the sulphurised hydrogenous smell is so powerful as to oblige many persons to return. The valley which encloses the volcano is about sixty fathoms long, fifty broad, and lies sixty fathoms higher than the level of the sea. It appears as if the volcano had long ago formed the hollow, in which it is situated, by splitting the mountain that surrounds the cavity, and by its eruption casting to a distance on one side those parts which covered

the

the centre or focus. In looking down into the crater great care must be taken that the ground, which rings below the feet, does not sink, which would expose the legs to the danger of being burnt. For this reason it is usual to send a guide before to point out the places that are secure, especially when the weather is changeable; for people may then be speedily surrounded by vapours that almost obscure the sun. It has also been remarked, that during rain the vapours are more abundant and thicker than at other times. It is difficult to say with any certainty what is the nature of the soil to be passed over in order to enter the crater; but it seems to consist of decomposed remains, or the scoriæ of different minerals, and particularly of pyrites, which however have changed their nature. As you advance farther, the surface of the earth appears more and more covered with sulphur, and you find a number of small spiracles, from which arises a burning vapour, and which are covered on the sides with sublimed sulphur that has a very beautiful appearance. All these apertures may be considered as so many apparatuses for distillation, which nature has prepared, in order to purify the sulphur. If you strike your stick against the ground in this spot, it occasions a vent of that kind, through which the vapour issues with a strong hissing noise, and so hot that it raises the thermometer ten degrees above the boiling point. From these apertures, whether the work of nature or of art, it appears that the whole surrounding district below the surface is filled with boiling water; but this water does not proceed from rain or from springs in the crater, but, in all probability, from the mountain which rises above the volcano on the eastern side. This is the more credible, as the top of this mountain ends in a kind of funnel, which is of great width, and consists of very marshy ground. Several small streams issue from it also at different heights, and, after traversing the surface of the crater, pursue their way through the valley and discharge themselves into the sea. The water of all these streams is exceedingly warm, and is

covered with a multitude of air bubbles, so that it sparkles like champagne. These bubbles exhibit all the phenomena of oxygen gas, which probably is disengaged from oxydes of various kinds with which it was combined in the earth. What among the phenomena of the crater excites most wonder are, twenty-two large basons, full of boiling water; some of which are twenty feet in diameter, and which may be considered as monstrous cauldrons placed over the most violent fire. The ebullition is so strong that water bubbles of four or five feet in height are thrown up, which raise the thermometer far above the boiling point; but this however is the case only in those where the water is from one to two feet in depth, though the depth in general amounts to eight or ten feet. You may walk round the edge of them without any danger, and contemplate at leisure this astonishing quantity of boiling water. It is of a black colour, oily, covered with scum at the edges, and diffuses a vapour which obscures the atmosphere. From this ebullition and high state of the thermometer, we might be induced to believe, that there is a great quantity of heat in these basons; but if you put your hand into the water, you find the heat less than that of boiling water. The ebullition also may proceed only from the vapours which rise from the bottom of the excavations with so much strength that they give the water a boiling movement; and, in the like manner, the rising of the thermometer ought to be ascribed to these vapours also. The surface of the ground is of a pale yellow colour, and besprinkled with a multitude of small shining crystals, for the most part crystals of sulphur. The upper part of the crater, towards the south-east, rises exceedingly steep, and is covered with a great number of other crystals lying in a kind of earth, which is partly calcareous, and partly of an unctuous nature like clay. Among these crystals there are some shaped like flat needles, and which are real crystals of sulphat of lime. Others exhibit all the properties of sulphat of alumine; others appear like sulphat of iron, greatly supersaturated with the acid;

and

and others like ferruginous pyrites covered with an efflorescence by the action of the atmosphere and water. The above-mentioned substances must be considered as the principal causes of the violent commotions which appear in this crater. They are supplied from a large stratum of pyrites; and from the violence of the combustion, we may conjecture that it must be very deep. It is probable also that this stratum is of considerable extent, for very hot springs are found at the distance of a mile both to the north and south of the volcano. Such substances accumulated in different parts of the earth, when accidentally combined with other substances, such as air, water, and inflammable bodies, produce earthquakes and other convulsions of nature. Though the internal re-action of these substances on one another seems to threaten danger, it however occasions no damage to the colony, because they have immediate communication with the atmosphere, and the whole soil is penetrated by water so that it cannot take fire: neither are coal, bitumen, or such inflammable bodies found in the neighbourhood.

II. *Account of the Method of Catching Wild Elephants at Tipura* in the East Indies.* By JOHN CORSE, Esq. From *The Asiatic Researches.*

IN the month of November, when the weather has become cool, and the swamps and marshes, formed by the rains in the five preceding months, are lessened, and some of them dried up, a number of people are employed to go in quest of elephants.

At this season the males come from the recesses of the forest into the borders and outskirts thereof, whence they

* The ancient name of the province was *Tripura*, or *with three towns*, which has been corrupted into *Tipra* or *Tipara*.

make nocturnal excursions into the plains in search of food, and where they often destroy the labours of the husbandman, by devouring and trampling down the rice, sugar canes, &c. that they meet with. A herd or drove of elephants, from what I can learn, has never been seen to leave the woods: some of the largest males often stray to a considerable distance; but the young ones always remain in the forest under the protection of the *Palmai*, or leader of the herd, and of the larger elephants. The *Goondahs*, or large males, come out singly, or in small parties, sometimes in the morning, but commonly in the evening; and they continue to feed all night upon the long grass, that grows amidst the swamps and marshes, and of which they are extremely fond. As often, however, as they have an opportunity, they commit depredations on the rice fields, sugar canes, and plantain trees that are near, which oblige the farmers to keep regular watch, under a small cover, erected on the tops of a few long bamboos, about 14 feet from the ground: and this precaution is necessary to protect them from the tigers, with which this province abounds. From this lofty station the alarm is soon communicated from one watchman to another, and to the neighbouring villages, by means of a rattle with which each is provided. With their shouts and cries, and noise of the rattles, the elephants are generally scared and retire. It sometimes, however, happens, that the males advance even to the villages, overturn the houses, and kill those who unfortunately come in their way, unless they have had time to light a number of fires: this element seems to be the most dreaded by wild elephants, and a few lighted wisps of straw or dried grass seldom fail to stop their progress. To secure one of the males, a very different method is employed from that which is taken to secure a herd: the former is taken by *Koomkees*, or female elephants trained for the purpose, whereas the latter is driven into a strong enclosure called a *Keddah*.

As the hunters know the places where the elephants come out to feed, they advance towards them in the evening with four Koomkees, which is the number of which each hunting party consists: when the nights are dark, and these are the most favourable for their purpose, the male elephants are discovered by the noise they make in cleaning their food, by whisking and striking it against their forelegs, and by moonlight they can see them distinctly at some distance.

As soon as they have determined on the Goondah they mean to secure, three of the Koomkees are conducted silently and slowly by their Mahotes (drivers) at a moderate distance from each other, near to the place where he is feeding; the Koomkees advance very cautiously, feeding as they go along, and appear like wild elephants, that have strayed from the jungle. When the male perceives them approaching, if he takes the alarm and is viciously inclined, he beats the ground with his trunk and makes a noise, showing evident marks of his displeasure, and that he will not allow them to approach nearer; and if they persist, he will immediately attack and gore them with his tusks; for which reason they take care to retreat in good time. But should he be amorously disposed, which is generally the case, (as these males are supposed to be driven from the herd at a particular period by their seniors, to prevent their having connection with the females of that herd,) he allows the females to approach, and sometimes even advances to meet them.

When, from these appearances, the Mahotes judge that he will become their prize, they conduct two of the females, one on each side close to him, and make them advance backwards, and press gently with their posteriors against his neck and shoulders: the third female then comes up and places herself directly across his tail; in this situation, so far from suspecting any design against his liberty, he begins to toy with the females and caresses them with his trunk. While thus engaged, the fourth female is brought near, with ropes and proper assistants, who immediately get under the belly of the

third female, and put a slight cord (the Chilkah *) round his hind legs: should he move, it is easily broken; in which case, if he takes no notice of this slight confinement, nor appears suspicious of what was going forward, the hunters then proceed to tie his legs with a strong cord (called Bundah †), which is passed alternately, by means of a forked stick and a kind of hook, from one leg to the other, forming the figure of 8; and as these ropes are short, for the convenience of being more readily put around his legs, 6 or 8 are generally employed, and they are made fast by another cord (the Daugbearce ‡), which is passed a few turns perpendicularly between his legs, where the folds of the Bundahs intersect each other. A strong cable (the Phand §) with a running noose, 60 cubits long, is next put round each hind leg immediately above the Bundahs, and again above them, 6 or 8 additional Bundahs, according to the size of the elephant, are made fast, in the same manner as the others were: the putting on these ropes generally takes up about 20 minutes, during which the utmost silence is observed, and the Mahotes, who keep flat upon the necks of the females, are covered with dark coloured cloths, which serve to keep them warm, and at the same time do not attract the notice of the elephant. While the people are busily employed in tying

* Chilkâ—is a very slight soft cord, which the hunters at first put around the hind-legs of a Goondah, before they begin to tie him: this is not used for Keddah elephants.

† Bundah—a middle-sized cord, six or eight cubits long, which is put round either the hind or fore legs of elephants, in order to secure them. From ten to twenty are employed.

‡ Daugbearce—is generally a continuation of every second Bundah that is put on, a few turns of which are passed round, where the folds of the Bundahs intersect each other, in order to fasten and keep them firm. When the Bundah is not long enough, another cord is made use of.

§ Phand—is a cable nearly the same size as the Dool, the noose of which is put round each leg of the Goondahs, and then it is tied to trees or stakes. The Phands, used for the Keddah elephants, are only about thirty cubits long.

the legs of the Goondah, he caresses sometimes one, and sometimes another, of the seducers (Kootne), examining their beauties and toying with different parts, by which his desires are excited and his attention diverted from the hunters, and in these amorous dalliances he is indulged by the females. But if his passions should be so roused, before his legs are properly secured, as to induce him to attempt leaping on one of the females, the Mahote, to insure his own safety and prevent him gratifying his desires any further, makes the female run away, and at the same time, by raising his voice and making a noise, he deters the Goondah from pursuing: this however happens very seldom, for he is so secured by the pressure of a Koomkee on each side, and one behind, that he can hardly turn himself, or see any of the people, who always keep snug under the belly of the third female, that stands across his tail, and which serves both to keep him steady and to prevent his kicking any of the people who are employed in securing him; but in general he is so much taken up with his decoyers, as to attend very little to any thing else. In case of accidents, however, should the Goondah break loose, the people upon the first alarm can always mount on the backs of the tame elephants, by a rope that hangs ready for the purpose, and thus get out of his reach. When his hind legs are properly secured, they leave him to himself, and retire to a small distance: as soon as the Koomkees leave him, he attempts to follow, but finding his legs tied, he is roused to a proper sense of his situation, and retreats towards the jungle; the Mahotes follow at a moderate distance from him, on the tame elephants, accompanied by a number of people that had been previously sent for, and who, as soon as the Goondah passes near a stout tree, make a few turns of the Phands, or long cables that are trailing behind him, around its trunk: his progress being thus stopt, he becomes furious, and exerts his utmost force to disengage himself; nor will he then allow any of the Koomkees to come near him, but is outrageous for some time,

time, falling down and goring the earth with his tusks. If by these exertions the Phands are once broken, which sometimes is effected, and he escapes into the thick jungle, the Mahotes dare not advance for fear of the other wild elephants, and are therefore obliged to leave him to his fate; and in this hampered situation, it is said, he is even ungenerously attacked by the other wild elephants. As the cables are very strong and seldom give way, when he has exhausted himself by his exertions, the Koomkees are again brought near and take their former positions, viz. one on each side and the other behind. After getting him nearer the tree, the people carry the ends of the long cables around his legs, then back and about the trunk of the tree, making, if they can, two or three turns, so as to prevent even the possibility of his escape. It would be almost impossible to secure an elephant in any other manner, as he would tear up any stake that could at the time be driven into the ground, and even the noise of doing it would frighten the elephant: for these reasons, as far as I can learn, nothing less than a strong tree is ever trusted to by the hunters. For still farther security, as well as to confine him from moving to either side, his fore-legs are tied exactly in the same manner as the hind-legs were, and the Phands are made fast, one on each side, to trees or stakes driven deep into the earth. During the process of tying both the hind and fore-legs, the fourth Koomkee gives assistance where necessary, and the people employed cautiously avoid going within reach of his trunk; and when he attempts to seize them, they retreat to the opposite side of the Koomkees, and get on them, if necessary, by means of the rope above mentioned, which hangs ready for them to lay hold of. Although by these means he is perfectly secured and cannot escape, yet as it would be both unsafe and inconvenient to allow him to remain in the verge of the jungle, a number of additional ropes are afterwards put on, as shall be mentioned, for the purpose of conducting him to a proper station. When the Goondah has

become more settled, and eat a little food, with which he is supplied, as soon as he is taken, the Koomkees are again brought near, and a strong rope (Pharah*) is then put twice round his body, close to his fore-legs like a girth, and tied behind his shoulder; then the long end is carried back close to his rump and there fastened, after a couple of turns more have been made round his body. Another cord is next fastened to the Pharah, and from thence carried under his tail like a crupper (Dooblah†), and brought forward and fastened by a turn or two, to each of the Pharahs, or girths, by which the whole is connected, and each turn of these cords serves to keep the rest in their places. After this a strong rope (the Tooman‡) is put round his buttocks and made fast on each side to the girth and crupper, so as to confine the motion of his thighs and prevent his taking a full step. These smaller ropes being properly adjusted, a couple of large cables (the Dools§) with running nooses are put around his neck, and after being drawn moderately tight, the nooses are secured from running closer, and then tied to the ropes on each side forming the girth and crupper already mentioned; and thus all these ropes are connected and kept in their pro-

* Pharah—a rope that is put round the body of an elephant, like a girth, and to which the Dooblah and Dools are connected.

† Dooblah—is that rope which is made fast on one side to the aftermost Pharah, then carried under the tail and fastened to both the Pharahs on the opposite side, so as to answer the purpose of a crupper, and to keep the Pharahs in their places.

‡ Tooman—is the rope that is passed round the buttocks of an elephant, and prevents his stepping out freely: it is fastened to the girth and crupper, that it may not slip down.

§ Dool—is a large cable, about sixty cubits long, with a running noose. Two of them are put round the neck of the elephant, and fastened to the foremost Pharah or girth, one on each side, in such a manner as to prevent the nooses from being drawn too tight or coming too far forward: and this is effectually done by the Dooblah; for, whenever the elephant draws back, the Dools pull the crupper forward, which must gall him very much, and prevent him from using all the force he might otherwise exert, in order to free himself.

per places, without any risk of the nooses of the Dools becoming tight, so as to endanger the life of the elephant in his exertions to free himself. The ends of these cables are made fast to two Koomkees, one on each side of the Goondah, by a couple of turns round the belly, close to the shoulder, like a girth, where a turn is made, and it is then carried across the chest and fastened to the girth on the opposite side. Every thing being now ready, and a passage cleared from the jungle, all the ropes are taken from his legs, and only the Tooman remains round his buttocks to confine the motion of his hind legs: the Koomkees pull him forward by the Dools, and the people from behind urge him on. Instead of advancing in the direction they wish, he attempts to retreat farther into the jungle; he exerts all his force, falls down and tears the earth with his tusks, screaming and groaning, and by his violent exertions often hurts and bruises himself very much; and instances happen of their surviving these violent exertions only a few hours, or at most a few days. In general, however, they soon become reconciled to their fate, will eat immediately after they are taken, and, if necessary, may be conducted from the verge of the jungle as soon as a passage is cleared. When the elephant is brought to his proper station and made fast, he is treated with a mixture of severity and gentleness, and in a few months (if docile) he becomes tractable, and appears perfectly reconciled to his fate. It appears somewhat extraordinary, that though the Goondah uses his utmost force to disengage himself when taken, and would kill any person coming within his reach, yet he never or at least seldom attempts to hurt the females that have ensnared him, but on the contrary seems pleased (as often as they are brought near, in order to adjust his harnessing, or move and slacken those ropes which gall him), soothed and comforted by them, as it were, for the loss of his liberty. All the elephants, soon after they are taken, are led out occasionally for exercise by the Koomkees, which attend for that purpose,

[To be concluded in our next.

III. On

III. On the Materials used for Manufacturing Cast Iron.

By Mr. DAVID MUSHET of the Clyde Iron Works.

Communicated by the Author.

THE operation of extracting crude or cast iron from the ores is one of the least complicated processes in the art of fusion. Simply the materials are thrown into the furnace, *stratum super stratum*, and crude-iron is the result. Experience no doubt at first tutored the manufacturer, and taught him by repeated lessons the just proportions necessary for the production of certain qualities of iron.

The materials used for the manufacturing of crude-iron in this island, before the application of pit-coal, present themselves in the following order: Charcoal of wood of different kinds, primary ores of iron, with various proportions of argillaceous or calcareous iron stones. Since, charcoal or coaks made from pit-coal, argillaceous ores of iron, with small proportions of Lancashire and Cumberland ores. Calcareous stones for a flux or solvent.

In speaking of some of these separately, I shall not confine my observations to their application to use in the island of Britain alone; but treat of them as connected with the operation of fusion for the production of cast-iron in general.

Charred wood is almost universally used throughout the Continent, as fuel for the production of cast-iron. From its great abundance in the northern countries, the discovery of pit-coal would be deemed of little advantage for many years to come*. The extensive woods in Siberia and Sweden afford a constant supply of fuel to the numerous iron works in those countries. The necessary regulations which the respective governments of each country have thought proper to enact, will in all probability preserve, during their existence, the necessary supply of fuel for the

* Pit-coal has been discovered in Siberia of various qualities and in great abundance, fit for the same purposes to which it is applied in this country.

manufacturers *. If the woods receive necessary care and attention after the first cutting, they will replace themselves at periods from 15 to 18 years. The charcoal used in Siberia is all made from the pine and larch, the country affording no other varieties of timber. In Sweden the manufacturers are supplied with a considerable proportion of harder woods, which is greatly in favour of the manufacture.

It has been already noticed, in a former paper, that the fuel used in Britain at an early period, and so far down as the beginning of the present century, chiefly consisted of wood. The kinds of wood used for this purpose were various; but char of hard wood, such as oak, birch, ash, &c. &c. was always preferred to that made from pine, holly, fallow, &c. &c. At the small remaining number of charcoal furnaces now in this country, the oak has still the undoubted preference. Its firmness and continuity enable it in the blast furnace to support and convey principle to the iron contained in a larger portion of ore, than charcoal made from softer wood. The same properties also enable it for a time to sustain a heavier pressure of air from the discharging pipe: this facilitates the reduction of the whole, and greatly augments the weekly produce in iron. The mode of preparing charcoal of wood for the blast-furnace, though extremely simple, is yet capable of being greatly misunderstood, so as to occasion a considerable waste of wood in the process. The following is the detail of an operation which I have seen successfully tried, and which was productive of excellent charcoal. It is the same I believe as is followed at the two charcoal furnaces in Argyleshire.

First of all, a plot of ground is raised a little higher than

* In Sweden there is a law restricting the manufacturers of iron to a certain annual produce; and this quantity is always in proportion to the ground attached to the work. In this manner the wood is enabled to replace itself at certain intervals; and each work is insured of an annual though moderate supply. The more extensive and unpeopled tracts of Siberia, render such exactitude in the execution of the laws less necessary.

the surrounding surface: this is made slightly convex. The burner commences by placing in the centre a circle of sticks, transversely inclining, and crossing each other near their tops. Around these are built successive circles of wood of various sizes, from 1 to 10 inches diameter; but care is always taken to place those of similar diameters in the same circle. A round of beams, of the largest nature, is immediately followed by one so much smaller as to fill up the interstices between the larger diameters, that no more air may be admitted than is necessary to excite gradual combustion. These are again followed by pieces of an increasing diameter. This mode of ranging the large and small sizes is continued till such time as the pile is deemed sufficiently large. The total width may then measure from 20 to 30 feet. The last layer is commonly composed of small brush-wood. The whole is then covered with turf, the grassy side towards the wood; a coating of earth is then applied all round the bottom of the pile, and firmly beat to prevent the unnecessary admission of air. A small funnel, or opening on the top, is preserved by the transverse position of the first layer of wood; this is generally about 18 inches deep, into which the burning fuel is introduced. Combustion is in this manner first conveyed to the top of the pile, and is continued by feeding the small craters with pieces of wood for 4 or 5 days. When the interior part of the fire next the top is deemed sufficiently kindled and spread over the whole diameter, a row of holes is opened a few inches below, each about two inches diameter. The hole at the top is then entirely shut up, and the fire, now completely spread, slowly descends to where the air is admitted by means of the small apertures. When this is observed by the burner, which is known by the disappearance of smoke and vapour, they are immediately shut up, and a second row opened 6 or 8 inches under the first. In this manner the fire is conducted to the foundation of the pile, and the whole mass exposed to proper combustion. The intention of the operation is to bring the whole pile to a state of complete ignition, but in such a manner

manner that no greater a portion of it may undergo combustion than is necessary to produce that effect. Hence the necessity for guarding against too free an access of air during the process. As soon as the operation is ended, which may last for 10 or 14 days, the whole is more closely covered up, and kept so till such time as the char is deemed sufficiently cool to be fit for drawing: it is then separated from the earth, and carried away in bags or in waggons. Those pieces of wood not sufficiently charred are by the workmen called *brands*, and are commonly used for fuel to the next fire.

The loss of weight in charring wood is inconceivably great. In the large way it is almost impossible to ascertain it to any degree of exactness. The qualities of wood are so various, and the tendency which some have beyond others of parting with their juices, even when exposed to the same temperature, render it at best but a matter of dubiety. I shall however insert a few which I have charred in the small way, and the results obtained from them; before weighing they were all exposed to the same temperature for a considerable time, and thoroughly dried.

It is however worthy of remark, that the produce in charcoal in the small way, does not give an invariable standard whereby to judge of that obtained on a large scale, where ignition is caused by the admission of external air into contact with the wood. In the large way the quantity of char afforded will depend more upon the hardness and compactness of the texture of wood, and the skill of the workman, than on the quantity of carbon it contains. In the following tables I have simply expressed the existence of the alkaline principle, in the various ashes obtained from the combustion of 1 pound of wood avoirdupoise weight: this may be of use to those who wish to make experiments upon the formation of pot-ash. It will also be observed, that there are some woods that yield a much larger proportion of carbon than oak: these, however, are either too scarce or too valuable to be applied to the manufacturing of iron in this country.

TABLE of the component Parts of 1 English Pound Avoirdupoise, or 7000 Troy Grains of the following Varieties of Wood.

	Water, Hydr. gas, Carb. acid.	Carbon	Ashes	Colour and Degree of Saturation of the Alkaline Principle.
Oak - -	5382,6	1587,8	29,6	Grey, sharply alkaline.
Ash - -	5688,2	1258,0	53,8	Whitish blue, do.
Birch - -	5650,2	1224,4	125,4	Brownish red, do.
Norway Pine	5630,9	1344,3	24,8	Brown, not in the least alkaline.
Mahogany -	5147,00	1784,4	63,6	Grey, sharply alkaline.
Sycamore -	5544,00	1381,4	74,6	Pure white, weakly do.
Holly - -	5524,4	1394,3	81,3	Do. sharply do.
Scotch Pine -	5816,7	1151,9	31,4	Brown, perceptibly do.
Beech - -	5537,3	1395,9	66,8	Greyish white, sharply do.
Elm - -	5576,6	1370,2	53,2	Grey, partially do.
Walnut - -	5496,5	1446,4	57,1	Pure white, light as down, weakly do.
Americ. Mapple	5553,2	1393,1	53,7	Dark grey, sharply do.
Do. Black Beech	5425,9	1301,8	72,3	Brown, do.
Laburnum -	5196,4	1721,0	82,6	White and grey, partially alkaline.
Lignum Vitæ	5083,00	1880,0	35,0	Grey, sharply do.
Sallow - -	5626,00	1294,3	79,2	Light grey, do.
Chestnut - -	5341,3	1620,6	29,1	Grey, do.

Parts in 100.

	Water, Hydr. gas, Carb. acid.	Carbon	Ashes	Colour, Nature, Compactness of the Charcoal.
Oak - -	76,895	22,682	,423	Black, close and very firm.
Ash - -	81,260	17,972	,768	Shining black, spongy, moderately firm.
Birch - -	80,717	17,491	1,792	Velvet black, bulky and do.
Norway Pine	80,441	19,204	,355	Shining black, bulky and very soft.
Mahogany -	73,528	25,492	,980	Tinged with brown, spongy, and firm.
Sycamore -	79,200	19,734	1,066	Fine black, bulky and moderately firm.
Holly - -	78,920	19,918	1,162	Dull black, loose and bulky.
Scotch Pine -	83,095	16,456	,449	Tinged with brown, bulky but pretty firm.
Beech - -	79,104	19,941	,955	Dull black, spongy, but very firm.
Elm - -	79,655	19,574	,761	Fine black, moderately firm.
Walnut - -	78,521	20,663	,816	Dull black, texture close, body firm.
American Mapple	79,331	19,901	,768	Dull black, texture close, moderately do.
Do. Black Beech	77,512	21,455	,033	Fine black, compact and remarkably hard.
Laburnum -	74,234	24,586	1,180	Velvet black, do.
Lignum Vitæ	72,643	26,857	,500	Greyish, resembles pit coal, coaks, do.
Sallow - -	80,371	18,497	1,132	Velvet black, bulky, loose and soft.
Chestnut - -	76,304	23,280	,416	Glossy black, compact and firm.

The advantages that charcoal possesses, beyond those of pit-coal, for the manufacturing of crude iron, are derived from the purity of its component parts, and the superior quantity of unalloyed carbon it affords to the iron. This principle is presented to the metal free from the combination of clay, lime, sand, and sulphur; with which pit-coal frequently abounds. A determinate quantity of charcoal by measure, will smelt and convey principle to three times the quantity of iron that can be done by the same measure of pit-coal coaks. Its greatest and most useful property, however, seems to be developed in the refinery fire, and similar bar-iron operations; where it manifests in the most evident manner its superiority over pit-coal, by shortening the tedious processes of the forge, diminishing the waste, and affording a much superior quality of iron for all the purposes of subsequent manufacture.

Pit Coal.

No sooner had the consequences of the general diminution of wood, for the purpose of making charcoal, been felt by individuals, whose interest it was to support the fabrication of iron, than their violent prejudices were laid aside against the use of pit-coal, and this mineral combustible substance was brought forward, and established as the basis of a profitable and useful manufacture.

Pit-coal has hitherto been better known, and its usefulness made more subservient to the purposes of life and of manufacture in Britain, than in any other country. This valuable fuel is generally found in strata of various dimensions, and of various inclinations from the parallel of the horizon. It is also found, though seldom, in vertical masses irregularly diffused, and less extensive than the former. Regular strata widely extended are found from 2 to 10 feet in thickness; those most commonly met with are from 3 to 6 feet*.

* There is at Dyfart in Fifeshire a regular stratum of coal upwards of 24 feet thick, and is the thickest ever heard of in this country.

The pit-coal in Scotland may be arranged under the following classes, of each of which there are many varieties: splint coal, free coal, and bituminous coal. To the former a just preference has always been given, for the superior effects it produces in the blast-furnace. Free coal seems to partake of the nature of the splint and the bituminous coal, and is frequently found interspersed with small layers of splint. It ought therefore to be considered as the medium state of the mineral. Under bituminous coal may be arranged the lighter varieties, known by the names of candle-coal, parrot-coal, &c. These hitherto have been deemed unfit for the manufacturing of crude iron in any profitable shape.

As in this place I mean only to convey a just idea of the materials used in the smelting process, I shall not enter into a comparative view of the relative effects which the various qualities of coal produce, when used in the smelting or casting-furnace; but confine my description to that quality which can be used for manufacturing crude iron to advantage. Of this kind there are two varieties; the pure splint and a mixture of splint and free coal, generally composed of alternate strata of each. Both these possess their advantages derived from local construction; the former being the most preferable, where a superiority of mechanic power affords the furnace a heavy and unremitted supply of air. The latter will be found to possess equal advantages, where a deficiency of power in the air machine conveys to the furnace but a sparing column of blast. The purer and the more approaching to splint is the coal, the more capable will it be of supporting unshaken a current of highly compressed air, and of conveying the carbonaceous principle to the iron; which stamps its utility and value. On the contrary, the softer and less connected the coal, the less capable is it of resisting the force of the blast, and of supporting a certain proportion of ore till such time as the metal which it contains imbibes the coally principle, so essential to its

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existing

existing as melting pig-iron; and which is always effected previous to separation—of course before the mixtures ought to come in contact with the blast.

To these general data, the following quality of coal found in different places in England and Wales claims exception. This coal is composed of a very small proportion of bitumen, and contains more carbon than any of the Scotch coals hitherto discovered. To the purity of the splint-coal it unites all the softness and combustibility of wood. The effects produced by it in the blast-furnace, either as to quantity or quality of cast-iron, far exceed any thing in the history of the manufacture of that metal with charcoal. At present there is one furnace in Wales that yields 60 tons of pig-iron upon an average weekly.

In preparing pit-coal for the blast-furnace, well understood among manufacturers by the term coaking, flat surfaces are appropriated. These are firmly beat and puddled over with clay, so as to pass the necessary cartage without furrowing or loosening the earth. These spaces form squares, more or less oblong, and are called hearths; upon which the pieces of coal are regularly placed inclining to each other. Great care is taken to place each piece upon the ground layer on its acutest angle, in order that the least surface possible may come in contact with the ground. By this means large interstices are preserved for the admission and regular communication of the air necessary to excite and effect complete ignition.

The quantity of coaks charred in one heap or hearth, is various at different, and even at the same works. Forty tons of coals is amongst the smallest fires, and some hearths again will admit of 80 or 100 tons. The length of the fire is in proportion to the quantity of coals built: the breadths and heights are also subject to no determinate standard; but are from 30 to 50 inches high, and from 9 to 16 feet broad. In building each fire, they reserve a number of vents reaching

reaching from top to bottom, into which the burning fuel is introduced. This is immediately covered by small pieces of coal beat hard into the aperture: these repress the kindling fire from ascending, and oblige it to seek a passage by creeping along the bottom, which is most exposed to air. In this progress the fire of each vent meets, and, when united, rise gradually, and burst forth on all sides at once.

If the coal contains pyrites, the combustion is allowed to continue a considerable time after the disappearance of smoke; the sulphur then becomes disengaged, and part of it is found in flowers upon the surface of the heap. If the coal is free from this hurtful mixture, the fire is covered up in a short time after the smoke disappears; beginning at the foundation, and proceeding gradually to the top.

The length of time necessary to produce good coaks depends upon the nature of the coal to be coaked, and the state of the weather. In 50, 60 to 70 hours the fire is generally completely covered over with the ashes of char formerly made: the coaks, thus entirely secluded from air, soon cool, and in 12 or 14 days may be drawn and wheeled to the furnace.

It is with pit-coal, in a great measure, as with wood, in the process of charring. Coals do not always afford a weight of coaks in proportion to the quantity of carbon in the coal. It depends more upon the capability of the coal to resist the waste occasioned by combustion, supported by external air, than upon the real quantity of carbon inherent in the coal; as may be seen by comparing the loss of weight which coals undergo in the large way, and the results obtained from the same coals, by burning them unexposed to external air in the small way.

The loss sustained in coaking coals fit for the purpose of manufacturing, or melting iron, is found to be nearly as follows;

2240 pounds of free coals	-	-	yield 700 lbs. coaks, loss 1540 lbs.
2240 - - of splint and free coal mixt	-	-	840 lbs. coaks, loss 1400 lbs.

2240 pounds of splint slightly mixt yield 1000 lbs. coaks, loss 1240 lbs.
 2240 - - of pure splint - - - 1100 - - loss 1120 lbs.

This great weight thus lost is chiefly carried off in smoke. If a vessel is placed, filled with cold water, in the midst of one of these massy columns of vapour, before the fire has penetrated to the surface of the heap, a considerable quantity of tar will condense upon its external surface: this will continue to increase till such time as the water assumes the temperature of the smoke. At many iron works from 300 to 1000 tons of coals are thus weekly reduced to cinder. What a prodigious quantity of bituminous vapour, furcharged with tar, ammoniac and oil, must for the present be lost!!

I have found the specific gravities of the above coals and coaks to be as follow :

	Sp. Gr.	lbs. Avoirdup.	Sp. Gr.
Bituminous coal -	1.1801—Cubic foot	72.60—the coak	.3985
Free coal and little splints	1.1954—Ditto	73.75 —Ditto	.4798
Mixture splint and free	1.2307—Ditto	76.91—Ditto	.6547
Pure splint - - -	1.3121—Ditto	82.00—Ditto	.9533

Results obtained from the same coals by ignition unexposed to external air :

Bituminous coal 100 pts. comp. of Bit ⁿ .	51.5	Carb.	3.65	Ash.	12	S.g.	.4534
Free coal, pure - - -	44.8	-	53.45	-	1.75	-	.4827
Mixture of free and splint - - -	45.5	-	51.2	-	3.3	-	.6698
Pure splint - - -	42.4	-	53.4	-	4.2	-	.9599

The comparative quantity of coaks produced from 100 parts in both ways will stand thus :

Bituminous coal coaked in air	31.20	Coaked, unexposed to air	49.5
Pure free coal and a little splint	37.50	Ditto - - -	55.2
Splint and free coal - - -	44.59	Ditto - - -	54.5
Splint, pure - - -	49.10	Ditto - - -	57.6

These experiments were performed on coals found immediately in this neighbourhood, part of which are used in the manufacturing of iron. The qualities of coal, however, even of the same seam, vary in different places.

Iron-stone.

The substitution of pit-coal in the blast-furnace, in place of the charcoal of wood, first introduced to general use those numerous strata of argillaceous iron ores found stratified along with the other secondary formations of our globe. The intimate connection which nature had imposed upon these two mineral substances, by the plentiful formation of them, almost always within convenient reach of each other, has been successfully traced and beneficially developed in their mutual application to the manufacturing of cast-iron.

Had nature not formed this immense store of iron so congenial to the use of pit-coal combined in its present form, the application of cast-iron to the various branches of machinery, and to the vast variety of useful and ornamental castings constructed for the conveniences and elegancies, had been greatly retarded, if not hitherto altogether kept back. At present it is by many believed—nor has any attempt in the large way ever contradicted it—that primary ores of iron, such as the Cumberland and Lancashire ores, are incapable of affording cast-iron sufficiently carbonated, when smelted alone with pit-coal coaks, to be re-melted to advantage in the manufacturing of castings*. Certain it is that a larger por-

* I have not heard of any attempt to produce carbonated cast-iron from these ores in the large way. The universal diffusion of iron-stones renders this superfluous; especially as the use of Cumberland and Lancashire ore can only extend to the neighbourhood, or at most can only be used by strangers whose works are within the reach of water-carriage. Their advantage therefore would only be local, and their utility restricted by the expence of carriage, of freight, or of both. As to the quality of iron they contain, I have not a scruple in asserting, that it can be called into existence by means of the assay-furnace sufficiently carbonated, even to excess, for any purpose. From these ores I have obtained reguli of super-carbonated crude iron covered with numerous specks of plumbago. The same results being obtained from iron-stones in the same manner, though with a different application of solvents, am I not at liberty to deduce, that similar effects could be produced in the large way, by varying the treatment and proportion of materials? Vide Assaying of Primary Ores by Fusion.

tion of coaks is at all times necessary to correct the bad effects which these ores, especially the former, would otherwise produce in the blast-furnace, though used in very small quantities.

Those iron-stones with which Britain so much abounds, and which are now universally used for the production of cast-iron with pit-coal, are commonly found in horizontal strata, subject to the same acclivity and declivity with the other stratified substances under the surface; their inclination from the horizon varying according to the nature of the ground, and the disposition of the imbedding and incumbent strata. Such variety is exhibited, that strata of iron-stone are found descending 1 yard in 24, 1 in 12, 1 in 8, and sometimes 1 in 4. Let A B (Plate I. Fig. 7.) represent a line drawn parallel to the horizon, and C D a stratum of iron-stone. Suppose the horizontal line continued for 24 yards: at that distance the iron-stone will be found to have descended one yard of perpendicular measure, at the termination of the lines A B, A D; and if the same line is supposed to measure 4 or 8 yards, it will represent those strata that are arranged at a more disadvantageous declivity. From this it is obvious, that where the acclivity or declivity of the metals is small, the most extensive and regular fields of iron-stone are to be found, and *vice versa* where the metals lay more on edge.

Iron-stones are generally found imbedded in schistous clay more or less compact, but which moulders away when exposed to air. They assume two different forms: regular connected strata called bands, and strata of detached stone found in distinct masses, from the size of the smallest bullet to the weight of several hundred pounds. Those of the small and middling sizes, and which generally wear a flat ovular form, are called ball-stones: those of greater weights are by the workmen denominated *lunkers*.

Both these species of iron-stone frequently accompany coal and limestone. In the former case they are commonly incumbent, and found almost in immediate contact with the coal;

coal; little extra labour is therefore requisite to bring down the stone; and the double purpose of obtaining both materials is thus advantageously answered.

When ironstone in bands accompanies limestone: it is most commonly of an inferior quality. Its component parts are chiefly calcareous, and the quantity of iron it contains is small. Ball ironstones found near to lime are of a much superior quality, and for the most part contain a considerable proportion of iron.

Thus stratified in the vicinity of lime, many ironstones are found with various impressions of marine remains; and not unfrequently compact and entire shells, univalve and bivalve, are found in the heart of the band. It is however still more difficult to conceive how shells could be deposited, distant from lime, imbedded in ironstone, incumbent on coal, at the great depth of 80 yards from the surface. In our neighbourhood, at this depth, a small band of ironstone is found completely covered and interspersed with distinct muscles of an ordinary size.

Among the great variety of rich ironstones found in Lancashire, the Rottenburn stone challenges particular attention, for the beautiful specimens it affords of vegetable decomposition and impression. This stone consists of a band and an accompanying ball. The former abounds with fine specimens of the ramification of trees, shrubs, &c. In the process of decay, and the substitution of mineral in place of vegetable substance, the more ligneous parts and the bark are distinctly preserved from the heart of the shoot. The former are found of a proper thickness, consisting of pure calcareous earth, encircling the central parts, which commonly have been displaced and occupied by the same compound as the general mass. As the external parts of the vegetable seem to have been laterally formed, it is presumed that they have withstood the decomposition of the softer parts, and have only been displaced afterwards by a filter which has contained calcareous earth in solution. This iron-stone contains 37 lb.

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in 100 extremely susceptible of receiving the carbonaceous principle.

The stratum of detached stone is externally marked with vegetable impressions, from the size of trees to small branches. The exterior appearance of this stone greatly resembles wood dug from a morass or bog, with knobs or excrescences of various sizes. These stumps are from 9 to 18 inches long, and are oval or round of various diameters: they split lengthways like a piece of wood, and their internal surfaces exhibit the most perfect traces of their original formation. In most of them the fibres, as in wood, are seen running lengthways, and a cross section presents the commencement of shoots of various thicknesses. In one of them I found a distinct nut, and a piece of the filament still in a vegetable state. The same piece of stone afforded a confused coagulation of mineral and vegetable substances. In the assay this ball-stone yielded me 40½ per cent. of iron,

Another variety of iron-stone, which we have in this country, and which will be deemed no less curious by the mineralogist, affords maltha, bitumen, mineral pitch, &c. This combustible is found in the heart of large flat rounded balls of iron-stone, occupying a number of interstices, and resembling a cement for the frittered pieces of stone. It is commonly found attached to pure calcareous spar, which has also found its way into these vacuities. I observed that where the spar was thickest, the bitumen was proportionally thin: in some places it totally disappeared, and the chasm became entirely filled with spar: this led me to conjecture, that the destruction of the bitumen was effected by the filter which had deposited the lime it held in solution; and that even at the time the stone was dug, nature was employed in this progressive and tedious operation. I have found some pieces of plant along with the bitumen, which resemble that from which soda is made; those, though preserved in shape, were equally inflammable with the pitch. The distillation of 437 grains afforded me a rough light charcoal, which weighed

only

only 49 grains ; this, when exposed to fire in contact with air, burnt without a residue ; hence I conclude it to be pure carbon. This iron-stone in the assay-furnace yields 36 pounds of iron in 100.

All these strata of iron-stone bear the most evident marks of the agency of water. It is not so difficult to conceive how regular strata of iron-stone should be formed by the deposition of water : but how such huge masses, broken off, detached, rounded and impressed with various external shapes, abounding with the forms of substances formerly foreign, now transposed, and forming part of the same mass ; regularly deposited in strata, sometimes incumbent, sometimes decumbent to lime, coal, and their own species, is a work of real admiration ; in attempting to solve which, conjecture must supply the place of certainty, and analogy must serve in place of strict demonstration.

The manner and disposition of the Rottenburn ball iron-stone resembles more an irregular diffusion of wood, felled into lengths, and afterwards changed to stone ; than a regular stratification, deposited by the decomposition of water, or the escape of an acid.

The phenomena attending water depositing matter in solution, and of transforming the nature of vegetables, wood, &c. I have frequently and satisfactorily observed. Within the last four months I have obtained strata of an inch thick, whose surface, exposed to the action of the water, displayed an entire covering of calcareous crystals of an ice colour, so small as not to be distinguished by the naked eye. The fracture of such a thickness presents from 12 to 15 various-coloured strata successively deposited ; chiefly lime, with a small portion of fine flint and magnesian earth. By exposing it a few days to dryness, it acquires consistency and firmness almost equal to limestone. Heat is requisite to disengage this sediment. Its affinity in this case is greatest to wood, less to iron, and least of all to lead. Pieces of wood boiled in this water become softened : the liquid penetrates to the heart of
the

the piece, opens the pores of the wood, and admits the particles of matter. By this accumulation of weight the wood sinks, and in 15 to 18 days a soft slime is formed over all its surface; this gradually hardens into a crust, and diffuses itself inwards: during the progress of formation the slimy matter which is next to the wood receives the impression of the fibres, and communicates their form to the mass. Hence impressions are conveyed to stones, which are afterwards formed when in a compact state.

I am afraid it will be thought that I have exceeded the limits I proposed to myself; but the few particulars I have related concerning the deposition of matter from water may tend to explain some part of the phenomena attending the formation of some iron-stones. I shall probably on a future occasion give some further observations concerning the effects of this water, and the progress it makes in substituting one species of matter in the room of another, and in the formation of strata.

Working of Iron-stone.

When iron-stone is found near the surface, it is only necessary to unbare the soil and the super-incumbent earths: the stone then presents itself like a pavement more or less inclined, and is easily raised by the application of wedges, bars, &c. &c. But as all secondary strata descend, according to the declivity imposed upon them by nature in their formation, it is obvious that, in proportion as the excavation extends at right angles to the line of level, the stone becomes gradually buried under an accumulating depth of earth, till such time as the expence of throwing this off exceeds either the value of the stone, or the expence at which it could be procured by a different mode of operation. It therefore becomes necessary to make perforations by means of horizontal galleries, extended under the soil, so as to fall in with the declivity of the strata: these catch the inclining stone for a stretch of 100 to 240 yards, according to the existent circumstances of the mine,

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These galleries are in Scotland called the barrow roads. Whenever the miner has arrived at the extremity of his working, he turns round, and commences an excavation on his right and left hand, proportioned to the rise and dip of the stone, to the extent of several yards on each; the accompanying shist and rubbish are packed into the vacuity behind him: should there remain any superfluity unpacked, it is wheeled to the mouth of the gallery along with the iron-stone. In this manner the miner returns, and brings along with him the whole iron-stone contained in 100 to 240 yards in length, and in 20 to 30 yards in width. The height of the gallery is commonly so small, that the miner is obliged to perform his work upon his side: the wheelers are likewise obliged to push the barrow on all fours. This species of working is called under cover; and the attainment of a band of good iron-stone, though only four inches thick, will sufficiently defray the expence of the operation. It is here also obvious, that this operation can only be carried a certain length in the same gallery, till such time as the expence of wheeling out the stone must exceed the value of that share of labour generally appropriated to it. A more economical method is therefore indispensibly requisite. This is effected by sinking a pit 160 to 200 yards farther on the same line of level. When the iron-stone is found, the miner sets off another gallery, or barrow road, towards his former working, and continues till he meets the termination of his *old waste*: as formerly, he now begins his retreat, and carries with him a similar portion of iron-stone from each side of the gallery. The quantity of iron-stone by weight obtained from such a *working*, depends entirely upon its extent and the thickness of the band. A square yard of iron-stone containing 9 cubical feet, as it lays stratified, will weigh from 1850 to 1900 pounds weight. The other side of the pit is next perforated, and the same operation completed. When the iron-stone is thus exhausted, another pit sunk at a similar distance from the termination of the second

cond gallery in the first, opens up a new field of supply. In this manner iron-stone is continued to be raised, till such time as the *field* is totally exhausted.

These extensive excavations commonly collect a considerable quantity of water, which would soon impede the progress of the workmen: various means have been contrived to remove this consequent obstruction. These have chiefly consisted in running a counter gallery as far to the declivity of the *metals* as possible, and of passing the water into it by means of filtration, or communications betwixt gallery and gallery. Where a sufficient quantity of running water presents itself, water-wheels have been applied, to extract the water from one general reservoir by means of pumps.

Strata of iron-stone are from $\frac{1}{2}$ an inch to 12 inches in thickness. Those of 3, 4, 5 and 6 inches are most commonly met with; they are also reckoned to contain a quantity and quality of iron superior to larger bands. Ball and lunker iron-stone, however large, contain always a superior quantity of iron, and are easier reduced in the blast-furnace.

IV. *On Preserving Seeds of Plants in a State fit for Vegetation.* By JOHN SNEYD, Esq. of Belmont, Staffordshire. From the Transactions of the Society for the Encouragement of Arts, &c. Vol. XVI.

MANY years ago having observed some seeds which had got accidentally amongst raisins, and that they were such as are generally attended with difficulty to raise in England after coming in the *usual way* from abroad, I sowed them in pots, within a framing; and as all of them grew, I commissioned my sons, who were then abroad, to pack up all sorts of seeds they could procure in absorbent paper, and send some of them surrounded by raisins, and others by
brown

brown moist sugar; concluding that the former seeds had been preserved by a *peculiarly favourable state of moisture* thus afforded to them. It occurred, likewise, that as many of our common seeds, such as clover, charlock, &c. would lie dormant for ages within the earth, well preserved for vegetation whenever they might happen to be thrown to the surface, and exposed to the atmosphere, so these foreign seeds might be equally preserved, *for many months at least*, by the kindly covering and genial moisture that either raisins or sugar afforded them: and this conjecture was really fulfilled, as not one in twenty of them failed to vegetate; when those of *the same kinds*, that I ordered to be sent lapped in common parcels, and forwarded with them, would not grow at all. I observed, upon examining them all before they were committed to the earth, that there was a prevailing dryness in the latter, and that the former looked fresh and healthy, and were not in the least infested by insects, as was the case with the others. It has been tried repeatedly to convey seeds (of many plants difficult to raise) closed up in bottles, but without success; some greater proportion of air, as well as a proper state of moisture, perhaps, being necessary. I should also observe, for the satisfaction of the Society, that no difference was made in the package of the seeds, respecting their being kept in husks, pods, &c. so as to give those in raisins or sugar any advantage over the others, all being sent equally guarded by their natural teguments. Whether any experiments of this nature have been made by others, I am totally ignorant; but I think that, should this mode of conveyance be pursued still more satisfactorily than I have done, very considerable advantages might result from it.

V. *A quick and easy Method of converting Weeds and other Vegetable Matter into Manure. By Mr. BROWN of Derby. From the Transactions of the Society for the Encouragement of Arts, &c. Vol. XVI.*

I BEG leave to communicate to the Society, and, if thought worth notice, by them to the world, a composition for manure. Fearful it would not answer the purpose so fully as I could wish, I deferred it from year to year; but I now find, both by numerous trials made by my friends, as well as myself, the very great utility of the composition, as well as its cheapness, with the capability of its being made in any situation and in any quantity. The mode of making it is as simple as, I trust, it will be found productive. It is nothing more than green vegetable matter, decomposed by quick or fresh-burnt lime. A layer of the vegetable matter about a foot thick, then a very thin layer of lime, beat small, and so on; first vegetable, then lime, alternately. After it has been put together a few hours, the decomposition will begin to take place; and unless prevented, either by a few fods, or a forkfull of the vegetables at hand, it will break out into a blaze, which must at all events be prevented. In about twenty-four hours the process will be complete, when you will have a quantity of ashes ready to lay on your land at any time you wish. Any and all sorts of vegetables, if used green, will answer the purpose; say weeds of every description. They will doubly serve the farmer, as they will not only be got at a small expence, but will in time render his farm more valuable, by being deprived of all noisome weeds.

But if this composition answers the purpose, as I flatter myself it will, a very short time will see almost every weed destroyed, which supposing to be the case, I have made my calculations with clover, grown for the purpose; for instance, I will take one acre of clover, which at one cutting will
produce

produce from fourteen to eighteen tons of green vegetable matter, and about three tons of lime: this, when decomposed by the above process, will yield ashes sufficient to manure four acres, the value of which I estimate at something under four pounds; the clover, according to the value of land here, I will say two pounds, which, take the average of the kingdom, is too much. The lime I will also say two pounds; but that will vary, according to the distance it is to be fetched. Take them together, I think will be **about** the average value. Now if this is the case, and as far as **I** have been able to try it I find so, how valuable must it be to the community in general! If it answers the purpose, I shall feel myself much obliged by the Society making it as public as they possibly can.

The vegetables should be used as soon after they are cut as possible, and lime as fresh from the kiln as the distance will allow of; as on those two circumstances depends the goodness of the composition.

VI. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE. From Journal des Mines. No. XX.

WHEN about to contemplate objects so complex as those that must be studied to found on observation the basis of a theory of the earth, it is indispensibly necessary that we should previously form a regular plan; prescribe for ourselves a certain order; and minute down, if I may use the expression, the questions which we wish to propose to nature. As the geologist commonly studies and observes while travelling, the least distraction may deprive him, perhaps for ever, of an interesting object. Even without interruption the objects of his study are so various and so numerous, that some of them may easily escape his notice. An observation which

appears important by engaging his whole attention makes him often forget others: sometimes he is discouraged by bad weather, or becomes absent through fatigue; and the neglect produced by all these causes gives rise to deep regret, and even frequently oblige him to turn back; whereas if he has a collection of memorandums on which he can from time to time cast his eye, he will be reminded of all those objects which ought to engage his attention. This collection, confined at first, will be extended and improved in proportion as he acquires ideas, and may furnish hints to travellers who, without being versed in geology, wish to collect, in the countries they visit, observations that may be useful to those who study that science*.

Agreeably to these principles I have always prepared for all my journeys a list of those objects, for examining which that journey was intended. I propose here, however, a more extensive plan. I wish to direct the traveller, and even the sedentary philosopher, in all the researches which ought to engage their attention, if they are desirous of contributing towards the progress of a theory of our globe. I do not flatter myself that I shall be able to give a complete view of every thing that remains to be done: what I offer will be only an imperfect sketch, but this sketch will be at least useful till some one produce a better. Several of the observations and questions which I here propose as problematic, seem indeed to have been already resolved; but as most solutions of this kind are founded merely on analogy, the contrary of which is always physically possible, it is proper, in my opinion, to keep the eyes of naturalists always open to the grand facts which may be interesting to a theory so difficult and of so much importance.

* Voyage dans les Alpes, vol. i. Preliminary Discourse.

CHAP. I.

Astronomical Principles.

1. A general system of cosmology, in what regards the earth considered as a planet.
2. The figure and dimensions of the earth determined.
3. The density of the earth determined by the deviation of a plummet near some mountains, the dimensions and density of which are known.
4. Whether any principles or hypotheses, depending on astronomical geography, can explain the great changes in the temperature of some parts of our globe?
5. The courses of comets. Whether it be possible that they may have met with, or still meet with, the earth in their orbits, and what are the effects of such a meeting?
6. Whether it be possible, I do not say probable, that a comet, by passing through part of the sun, may have detached from it the earth and the other planets?
7. Is it probable that the earth's rotary motion has been formerly more rapid than it is at present?
8. If the grand chains of mountains existed before the rotary motion of the earth, is it possible that that motion produced any change in their original situation*?

CHAP. II.

Chemical and Physical Principles.

1. The theory of attraction and chemical affinities; of solution, crystallisation, and precipitation.
2. The theory of elastic fluids in general, and the cause of their elasticity†.
3. The theory of caloric and light; of the origin and nature of the different gases, and of the atmosphere. Electricity, and the aurora borealis.

* Tableau des Etats Unis. Note of M. A. Pictet, p. 125.

† System of M. Le Sage.

4. The theory of the calcination of metals, and of the decomposition of water.

5. Measuring heights by the barometer.

6. How the temperature of climates is modified by the winds, evaporation, the nature and elevation of the ground.

7. Whether these causes are sufficient to explain certain changes, such as that of the plants and animals of warmer countries having been able to exist and multiply in the coldest countries?

8. Mineralogy, the nature of earths, stones, salts, bituminous substances and metals. The principles of their analysis and nomenclature.

9. If it be possible to transmute one earth or one metal into another. For example, if it be possible that siliceous earth can be changed into calcareous earth in the bodies of marine animals; or, reciprocally, that calcareous can be changed into siliceous earth in mountains of chalk?

10. If it be probable, according to the conjecture of Lavoisier, that earths are the oxyds of metals?

11. What idea can we form of one or more solvents which, either simultaneously or successively, may have rendered soluble in water the different mineral substances which we see on the surface and in the bowels of the earth?

12. Can we believe that these solvents may have been afterwards destroyed; and that it is in consequence of their destruction that the matters they held in solution were precipitated and became crystallised?

12. A. Or, can we believe, with Dolomieu, that all crystallisations may take place without previous solution; and that it is sufficient for this operation that the bodies be reduced to their elementary parts, and that these parts be suspended in a fluid which gives them liberty to unite by their corresponding faces?

13. Can we suppose that the electric and magnetic fluids enter, as elements, into the composition of bodies?

14. Does

14. Does it appear probable that the nitric, muriatic, and boracic acids, as well as the three alkalies, are of new formation; while the sulphuric, phosphoric, carbonic, tungstic, molybdic, and arsenic acids existed before the formation of animals*?

15. If we believe that the mineral alkali or soda was of ancient formation, may we not suppose that the ancient ocean held this alkali in solution? That would explain how it might have dissolved siliceous earth and argil without being able to nourish animals. Afterwards, when the marine acid was formed, or had issued from some cavity, the sea might have become proper for animals, and improper for the solution of siliceous earth and argil.

16. Is it probable that in the first ages of the existence of our globe its atmosphere was higher than at present; that its lower strata were thus of a much greater density, and susceptible of receiving from the sun a greater heat?

17. May we presume that the waters of the ancient ocean, before the formation of the primitive mountains, had a heat superior to that of boiling water?

18. What temperature may we suppose at present to exist at the centre of the earth?

19. Is it possible that the quartzey earth found in petrified vegetables and animals has proceeded from the substance of these bodies?

CHAP. III.

Historical Monuments.

Though the grand revolutions of our globe have been anterior to all histories and monuments of art, light may, however, be acquired from the traditions which history has preserved †:

* *Theorie de la Terre* de M. de Lametherie.

† And also from the analogy between the languages and customs of different countries. C.

1. In regard to the situation of those countries which were first inhabited.

2. In regard to the order in which they were successively inhabited.

We shall thence see whether it be true, as some traditions assert, that this habitation was determined by the progressive retiring of the waters; and by coming to periods less remote and less involved in obscurity, history may point out to us—

3. The changes undergone by the seas, lakes, rivers, and even some of the solid parts of the globe.

4. It will throw some light on the origin of the different races of men and animals; on the modifications they have experienced; and on the real or pretended loss of some of these races.

5. The deluges or great inundations; their epochs and extent.

6. Whether there exist proofs of the diminution of the water of the sea; and what may be the cause of it?

7. If it be probable that large caverns have been opened in the bowels of the earth, and that these caverns swallowed up a part of the waters?

8. Do there exist any historical monuments which prove that the countries at present cold were formerly so warm as to favour the multiplication of plants and animals which are no longer found but in the torrid zone?

CHAP. IV.

Observations to be made on the Seas.

1. Their form, extent and situation; those of their great gulphs and straits; their relative elevation.

2. The sensible flux and reflux out of the ocean, at the extremity of some gulphs and in some straits; their periods and their limits.

3. Their bottom; notes of the places where they are deepest, and of the most remarkable shoals; their position and extent.

4. Currents

4. Currents at the surface or at different depths; their direction, velocity and limits; their relation to rivers, the winds, and form of the coasts; the matters which they accumulate, and the places where they deposit them.

5. Subterranean mountains and valleys; their relation with islands, and even with the terrestrial mountains and valleys.

6. The nature of the mud, sand and rocks, of which the bed of every sea is composed.

7. An analysis of the water of the different seas; and, at least, their saltness at different depths and in different climates.

8. Their temperature at different depths and in different climates.

9. The fish and testaceous animals peculiar to different seas, depths and climates, which may serve to characterise them.

10. In what the present seas differ, in a physical and chemical view, from the great ocean, which, according to some systems, is supposed to have covered the whole surface of our globe?

11. Can we believe that there are still formed stoney strata at the bottom of the seas, and that their waters have consequently that dissolving power which is supposed to have belonged to the ancient ocean?

CHAP. V.

Observations to be made on the Borders of the Sea.

1. If the sea coast is steep; if it forms steep hills, to observe their height, their nature, and the strata of which they consist *.

2. To seek on these hills traces of the effects or abode of the waters at different heights above the present level, and at different depths below, such as furrows, caverns, shells,

* 1. A. To note down every thing that relates to the destruction, more or less rapid, of these hills, and the banks and accumulations formed chiefly at the mouths of rivers. C.

pholades; to search also for vestiges of the labours of man, such as excavations, rings for making fast vessels; in a word, to endeavour to ascertain whether the sea has the same level as it had in the remotest ages.

3. In case the level has changed, to examine whether that effect has been produced by a change in the sea itself, or whether the shore rather has not been raised or depressed.

4. If the sea coast is flat, to discover to what distance its acclivity is insensible; and to examine the nature of the sand found on the shore.

5. Whether the grains of that sand are round or angular, crystallised or not, quartzzy or calcareous, or of any other kind of stone.

6. To endeavour to discover its origin, whether it can be considered as produced by detrition from the neighbouring mountains or hills; whether it may not have proceeded from some river which had its mouth in the neighbourhood, or whether it may not have been brought from the bottom of the sea itself by the tide and the waves?

7. Whether this sand contains, like that of Rimini, microscopic shells of the order of those called *pelagian*?

8. Whether there are not shells on the borders of the sea; and, if there are, to determine those by which that coast seems to be characterised.

9. Whether there are any rolled pebbles?

10. To examine, as in No. 2, chiefly on the shore, and even pretty far up the country, whether there are any proofs that the sea gains on the land, or the latter on the sea; and, in case the sea seems to recede, to discover whether that may not be occasioned by the land rising by accumulations washed down from the higher grounds; by subterranean causes, or reciprocally.

11. If a progressive displacing of the ocean really exists, by what observations can the systems, which tend to explain it, be verified? Some have employed, for that purpose, the currents produced by the trade winds; others, the shock of the

the tides and currents; and others, a change in the earth's centre of gravity, occasioned either by deposits transported by rivers to the sea, or by the progressive movement of some mass detached from the interior parts of the earth supposed to be concave*.

[To be continued.]

VII. *Analysis of the Spinel Ruby.* By C. VAUQUELIN, Inspector of Mines and Member of the French National Institute. From Journal des Mines, No. XXXVIII.

IRON and manganese have long been considered as almost the only metals employed by nature to colour minerals; but though these metals may assume a multitude of different shades according to the proportions of oxygen which they contain, we however often see in nature bodies possessed of colours which neither iron nor manganese ever formed artificially or naturally when pure, and it is probable that we shall one day find many other colouring metals and also stones and earths.

I have already announced that the colour of the emerald, which all chemists ascribed to iron, is owing to the oxyd of chrome. In examining the peculiar red colour of the spinel ruby with the results of the analysis lately made of it by Professor Klaproth, I began to doubt of that rich and beautiful colour being produced by the oxyd of iron, of which the Professor found only 1.5 in 100†. My doubts in this respect were still increased by reading in Bergmann that the ruby fused with borax communicates to it a beautiful green

* 12. To observe whether there are not daily formed different kinds of stones in the places which are washed by the waters of the sea. C.

† The number, nature and proportion of the principles found by Klaproth in the spinel ruby are stated as follows: Alumine 76; siliceous earth 16; magnesia 8; oxyd of iron 1.5:—Total 101.5,

colour,

colour, as well as by a passage of Klaproth, in which he says, that magnesia extracted from that precious stone, being dissolved in the sulphuric acid, had given to it a green colour. The rubies of different colours preserved in collections, such as the sapphire-blue in the possession of the Hon. Mr. Greville, the green belonging to Mr. Hawkins, and the white in the collection of Mr. Macie of London, authorised me to suspect that iron is not the colouring principle of that stone.

These different considerations induced me to make a new analysis of the spinel ruby: and the result of this labour will prove, that my doubts were not without foundation, and that it not only does not contain a single particle of the oxyd of iron, but that there is even no siliceous earth in it, as announced by Klaproth. The rubies employed for this analysis were crystallised, transparent, and free from any foreign mixture.

EXP. I. A hundred parts of this stone being exposed to a violent heat, lost nothing of their weight, but their tint was weakened and changed to a rose colour.

II. A hundred parts of the same stone reduced to a fine powder, and strongly heated in a charcoal crucible, were agglutinated into one mass of a greenish grey colour.

III. A hundred parts of the small fragments of rubies reduced to an impalpable powder in a mortar of flint, were increased five parts.

IV. I heated for an hour, in a silver crucible, 100 parts of a ruby thus pulverised, with 300 parts of caustic potash: the mixture was not fused; on the contrary it was reduced to a pulverulent mass of a green colour, of which some particles were merely agglutinated. I mixed this with distilled water, in which it was all so nearly dissolved that there remained of it only some particles which weighed scarcely three parts. I poured upon the solution, which remained still mixed with the undissolved matter above-mentioned, some diluted muriatic acid. The first portions of this acid made the solution assume the appearance of a mass as thick as soup (*bouillie*), which was re-

dissolved,

dissolved, at least for the greater part, by additional quantities of the acid. I warmed the solution by a gentle heat, and having filtered it, there remained on the paper three parts of a rose-coloured powder, which was ruby, not decomposed. This I placed apart, that I might operate only on that portion which had been attacked.

V. The muriatic solution above mentioned having been evaporated to dryness by a gentle heat, I poured upon the residuum a large quantity of distilled water: almost the whole of it was dissolved. There remained only five parts of a grey powder, which melted with borax, to which it communicated a green colour.

VI. I subjected these five parts to different tests, which shewed, that they were siliceous earth mixed with a little alumine, and coloured by a matter, of which I shall speak hereafter*.

VII. I precipitated the muriatic solution of Exp. V. with carbonat of ammonia. When I judged that I had added a sufficient quantity, I boiled the mixture for a quarter of an hour, in order to expel the carbonic acid, and favour the precipitation of the lime or magnesia, if there were any of these in it. By these means I obtained an abundant white precipitate, which I boiled with a solution of caustic potash. The greater part of this precipitate was dissolved. There remained only $10\frac{1}{2}$ parts of a brown substance inclining to violet, but which turned to a yellowish-green colour, by drying in a gentle heat.

* In another analysis of the ruby I had for residuum, after the evaporation of the muriatic solution, but five parts and a half of siliceous earth, slightly coloured green, and without any mixture of alumine. This difference arises from the degree of heat given to the matter towards the end of the evaporation, or from the saline mass not being equally stirred throughout. In the latter case it happens that there are parts which dry too much, and others which do not dry sufficiently. Hence it happens that molecule of alumine are abandoned by the acid, while molecule of silica remain combined; and this was the case in my first analysis.

VIII. These $10\frac{1}{2}$ parts were dissolved by the sulphuric acid. The solution had a greenish colour. This solution mixed with the saturated carbonat of potash, precipitated a greenish matter, which, when washed and dried, weighed two parts. A small portion of this precipitate melted with borax communicated to it a beautiful emerald green colour*. This matter, which I placed apart, I shall speak of hereafter.

IX. As I had dissolved in the sulphuric acid $10\cdot5$ of matter, and as the carbonat of potash precipitated only 2, there must have remained $8\cdot5$ in the solution. Suspecting therefore that the matter was retained there by an excess of the carbonic acid, I boiled the liquor for some minutes, and I obtained a white granulated precipitate, weighing 16 parts, which by calcination were reduced to 8. This matter, combined with the sulphuric acid, gave a salt crystallised in tetrahedral prisms, terminated by pyramids with four faces, the taste of which was first sweet, and afterwards bitter; which was not precipitated by the saturated carbonat of potash; was only partly so by ammonia; and, in a word, which presented all the characters of sulphat of magnesia. The ruby therefore, according to this experiment, should contain 8 parts of magnesia in 100; but as $\frac{1}{2}$ part was wanting in that subjected to experiment, we may estimate the quantity at $8\cdot5$.

* In heating the colouring matter of the ruby with borax over charcoal, and stopping the operation before the effervescence had ceased, I have twice obtained a vitreous globule of a red colour, perfectly similar to that of the ruby; but in heating again this red globule, the effervescence was renewed, and the globule became of an emerald green colour. In vain did I afterwards try to make the red colour re-appear, whether I applied the exterior or the interior flame of the blow-pipe. It is even very difficult to obtain, in the first instance, the vitreous globule of a red colour. It is necessary for that purpose that the colouring matter should not touch the charcoal; that it should not be added till the borax is melted; and that it should be heated with the exterior flame. Though I often attempted to produce this phenomenon, I never succeeded but twice.

X. I united the five parts of Ex. VI. and the two parts of Ex. IX; boiled them five or six times successively in a porcelain vessel with concentrated nitric acid, evaporating each time to dryness. The matter at first assumed a beautiful dark green colour, and at the end of each operation it boiled and was puffed up like alum. At last, when the greater part of the acid was evaporated, and the matter began to dry, it assumed an orange yellow colour. After treating the matter in this manner, I mixed with it a little pure caustic potash; and when the mixture was well formed and reduced to a kind of paste, I diluted it with distilled water, in which almost the whole of the matter was dissolved. Nothing remained but a little grey matter which weighed about $1\frac{1}{2}$ parts, and which I found to be siliceous earth. The alkaline solution had a weak golden yellow colour; and as it contained an excess of alkali, I added, in order that it might be saturated, a few drops of nitric acid. By this addition there was produced a slight white precipitate, which weighed at most one part, and which appeared to me to be alumine. The liquor had then a reddish colour.

XI. As I suspected, from all the phenomena which had appeared during the course of this analysis, that the colouring matter of the ruby was chrome, I mixed the liquor of the preceding experiment, first, with nitrat of lead, and I immediately obtained a precipitate of a beautiful orange-yellow colour; second, with nitrat of mercury, and there was produced a deposit of a cinnabar red colour; and, third, with the nitrat of silver, which gave a precipitate of a crimson red colour. I was convinced by these phenomena that the ruby, like the emerald of Peru, contains a certain quantity of chrome, to which it is indebted for its colour. But it seems difficult at first to reconcile the colour of the emerald with that of the ruby, by referring them to the same substance; for nothing seems more remote from green than red. If we however recollect that this metal is susceptible
of

of assuming different colours according to the quantities of oxygen which it absorbs; that when it is saturated with this principle, it is red and acid; and when it contains less, it is green, and in the state of an oxyd, we shall readily conceive how this oxydated metal may colour the emerald and the ruby. It follows then from these considerations, that chrome exists in the emerald in the state of an oxyd, and in the ruby in the state of an acid; and that this acid is there, doubtless, in a saline combination with alumine or magnesia, and perhaps with both at the same time. With regard to the proportion of the chromic acid in the ruby, I have not been able to determine it very accurately, on account of the affinity which it has with alumine, from which it is difficult to separate it completely. I am however of opinion that it may be estimated, without committing any very sensible error, at between 5 and 6 parts in 100 of ruby.

XII. I now return to the solution of alumine in caustic potash (Exp. VII.). I super-saturated it with the muriatic acid, and precipitated it afterwards by the carbonat of ammonia. The deposit washed and kept at a red heat for a considerable time weighed 85 parts. This matter had all the properties of alumine. As I had however scarcely found any siliceous earth during the course of this analysis, and as Klaproth says that he obtained 16 in 100 parts of this stone, I wished to assure myself whether there might not be some of it remaining in the alumine. For that purpose I dissolved the 82 parts above-mentioned in the sulphuric acid, and I indeed obtained an insoluble residuum which weighed three parts, and which was siliceous earth. This, with the $1\frac{1}{2}$ part obtained (Exp. X.), makes $4\frac{1}{2}$ parts. But it must be recollected, that during the pulverisation of the 100 parts of ruby, the details of the analysis of which I have explained, 5 parts were taken from the mortar of flint; from which it follows, that the $4\frac{1}{2}$ parts of this substance found in the course of these operations did not belong to the ruby. Whatever method

method I employed, and whatever care I took, I could never obtain a larger quantity, and therefore it is very probable that Klaproth was deceived in this respect.

Now, to establish the proportions of the principles of the ruby, I must here observe, that of 100 parts subjected to analysis, 97 only were attacked; but 97 having furnished 85 of alumine (Exp. XII.), 3 of which were to be taken away for the siliceous earth, 100 would have given 82.47; 8.5 of magnesia having been obtained from these 97, 8.78 would have been found in 100. In the like manner, instead of 6 of the chromic acid, we should have had 6.18. Thus, 100 parts of spinel ruby consist of alumine 82.47, magnesia 8.78, chromic acid 6.18. Loss 2.57. Total 100.

XIII. To prove the correctness of the results of the preceding analysis, I repeated it by following another method. I heated 100 parts of ruby, reduced to a fine powder, for several hours with concentrated sulphuric acid. I obtained a solution, almost complete, by the addition of a sufficient quantity of water. There remained nothing but 5 or 6 parts of a grey powder, which had all the characters of siliceous earth, and which was only mixed with a little chrome.

The solution evaporated to the consistence of syrup gave radiated crystals without solidity; but these crystals, re-dissolved in water, and the solution mixed with a sufficient quantity of the sulphat of potash, gave octaedral crystals of alum. The whole 100 parts of the ruby thus dissolved in the sulphuric acid furnished me, in several successive crystallisations, with about 800 parts * of alum, without reckoning the latter portions which I could not entirely separate from the mother water. This mother water had a green colour, and a bitter slightly metallic taste. I diluted it with water, and mixed with it a solution of the carbonat of potash. There was formed a greenish white precipitate, which was a mixture of alumine and the oxyd of chrome. The liquor filtered

* The same article in the *Annales de Chimie*, Messidor An. VI. states this product at 775. EDIT.

and exposed to heat deposited a white powder, which, washed and dried, weighed 17 parts, that were reduced to 8.3 by calcination. They consisted of magnesia, still mixed with a few particles of oxyd. The precipitate formed in the mother water by the carbonat of potash was treated with a solution of caustic potash. By these means the alumine was dissolved, and the oxyd of chrome remained without undergoing any sensible alteration: it weighed 5 parts.

This analysis perfectly confirms the former; for, some slight differences in the proportions excepted, it absolutely gave the same results. It proves above all that the ruby does not contain siliceous earth, and that the small quantity found in the products was furnished by the mortar in which the stone was pounded.

I must here observe, that it does not always happen that the whole mass of the ruby is dissolved during the first operation. There remains sometimes several parts which have undergone no alteration. This depends on the time employed for ebullition, and still more on the degree of fineness to which the stone is reduced before it is subjected to trial. But when that happens, after having washed the residuum, which is insoluble in the acid, it must be dried, pounded again, and treated in the same manner as before. Nothing then ought absolutely to remain but the siliceous earth belonging to the mortar.

XIV. The muriatic acid dissolves the ruby also: but a considerable portion of it is required; because it volatilises in a moderate heat, and without a strong degree of heat it makes no sensible impression on that substance. I observed that this acid dissolves the principles of the ruby in the same proportions as they hold between themselves in the stone; for the portion not attacked absolutely preserves the same shade of colour as that which it had before subjected to the action of the acid. This proves that it does not dissolve one principle in preference to another, and that they are in a state of real combination in the ruby.

From these considerations it would appear natural to consider the ruby as a saline substance, composed of two bases, alumine and magnesia, and of an acid called the chromic acid.

When I announced to the National Institute that I had not found magnesia in the ruby, I was however far from imagining that Klaproth was deceived; so much confidence did I place in the labours of that able chemist. I chose rather to conclude at that time, that the ruby I had examined was different from his. But I was in an error in that respect, as I was convinced by a new analysis, which I made of about 16 grammes of the same ruby; and it was from this latter labour, carried on in a manner somewhat different, that I established the proportions of the principles of this stone, as already enumerated. This proves the necessity of employing rather large masses, in order to find small quantities of matter. I thought it my duty to make this public acknowledgement, both that I might render justice to accuracy and to the sagacity of a man who has given so many proofs of it, and to avoid the reproach which might have been thrown out against me, of wishing to conceal an error into which I had fallen.

VIII. *Description of a remarkable Spring of Fresh Water, which rises through the Water of the Sea. By the Abbé SPALLANZANI. From the Journal de Physique, Vol. XXIX.*

THIS spring rises through the salt water at the distance of sixty-five feet from the shore and about a mile from Spezia. It raises itself some inches above the surface of the sea, and forms a sort of accumulation, shaped like a button of about twenty feet in diameter. This button, when the sea is perfectly calm, is full of watery radii, exceedingly perceptible. The water of which they are formed seems a little turbid; and this is very apparent, especially when it has

rained: the surrounding water is on the other hand perfectly transparent. These radii will not suffer a boat to remain steady on the centre of the button, but, as may be readily supposed, throw it back to the circumference. M. Spallanzani, however, found means to fix himself in that position, and was thence enabled to examine carefully the water at the bottom, as well as that at the surface.

The water at the surface is not fresh, but a little less salt than that by which it is surrounded. The depth of the spring is $38\frac{1}{2}$ feet. When the heaving-lead approaches the bottom, it is observed that the small line to which it is made fast begins to tremble; and as this trembling is observed no where else, it is plain that it is occasioned by the violent impulse of the water of the spring against the bottom of the lead. The water being less salt at the surface than the sea-water, with which it has mixed itself, it is natural to suppose that it is perfectly fresh at the bottom. To ascertain this, M. Spallanzani invented a machine, by which he could draw up some of it from the bottom, in such a manner as not to be mixed with the salt water by the way; and the water procured in this manner, though exceedingly turbid and slimy, was found to be perfectly fresh. He remarked also, that this water, when compared with the sea-water, was remarkably cool, which arose probably from its rising from some depth under the earth. The brass machine also was once very much beat together, which could be occasioned by nothing else than the violence with which the water issued from the ground, and by which the machine had probably been dashed against a stone.

M. Spallanzani is of opinion that the origin of this spring is as follows:—There are two small streams which flow from the side of a hill at the distance of three miles from Spezzia. These streams are afterwards united, and throw themselves into an unfathomable abyss, from which the water, as it is sufficiently secured from the summer heat, forces its way through the earth, and supplies sufficient nourishment to the fountain that springs up through the salt water.

X. *Experiments respecting the Effects of Electricity on the Fermentation of Vegetable and the Corruption of Dead Animal Substances.* By M. ACHARD. From *Mémoires de l'Académie de Berlin*.

It is a well-known observation, that, after a storm, flesh, whether raw or boiled, acquires a putrid smell, which in the latter is particularly acid. It is known also, that grain suffered to ferment for the purposes of brewing or distilling, undergoes, during stormy weather, very sudden and perceptible changes. On such occasions it is often extremely difficult to observe where the first degree of fermentation ceases, as it passes so speedily, and the second degree or the acetous fermentation takes place before one is aware. To ascertain, therefore, whether the electric matter, which during stormy weather is so abundant in the atmosphere, has any share in these phenomena, M. Achard made the following experiments.

He cut a piece of raw beef into three parts, and electrified the first positively for ten hours without any shock; the second he electrified for as long negatively, and the third he did not electrify. These three pieces were left in the same apartment, and exposed to the same degree of heat. When examined next day, both the pieces which had been electrified appeared to be tender, but were free from the least bad smell. On the fourth day the electrified flesh had an intolerably fetid smell, and that which had not been electrified began to smell a little.

M. Achard repeated these experiments with boiled veal. That which was electrified had the next day an acid smell and an unpleasant taste; but that which had not been electrified continued sweet for three days, and only on the fourth day began to have an acid smell.

M. Achard then killed several birds by electric shocks, and at the same time deprived others of life by sticking a

needle through their heads, and, placing them all in the same temperature, covered them with glass receivers in order to preserve them from insects. Having observed the gradual progress of corruption in both, he plainly perceived that it took place much sooner, and advanced more rapidly in those killed by electric shocks than in those deprived of life by the needle. In those also to which a stronger shock had been given, the degree of corruption was far stronger than in the others; and the cause in all probability was, that in this case the vessels containing the animal fluids were suddenly destroyed, by which means these fluids had diffused themselves through the particles of the body, and might thus accelerate putridity.

It clearly follows from these experiments, that electricity accelerates corruption, and that the putrefaction of flesh after a storm must be ascribed solely to the more abundant accumulation of the electric matter at that time. M. Achard saw that this was the case in regard to several persons killed by lightning. The body of a farmer, who lost his life in this manner on the 2d of July, between five and six o'clock in the evening, emitted next morning a very perceptible fetid smell, which in the evening was totally insupportable.

M. Achard took a handful of rye, which had been brought to a state of fermentation in order to be distilled, and divided it into two portions, one of which he electrified. Five hours after being electrified, the vinous fermentation was over in the first portion; but this was not the case in regard to that which had not been electrified, till after eight hours. M. Achard repeated this experiment in such a manner that he sent a number of strong sparks through a portion of rye, instead of giving it an electric bath, and always found, except in one case, that fermentation was accelerated by the electricity. The case in which a contrary effect was produced, may have been occasioned by some circumstance which escaped M. Achard's attention.

On this occasion M. Achard made two experiments also, in order to ascertain what effect would be produced on air when electrified without sparks. The object of his first experiment was in particular to discover whether the atmosphere, by being electrified, would become oxygenated, or retain its goodness; and that of the second, to determine whether a certain volume of air would be enlarged when electrified positively, or be diminished when electrified negatively.

For this purpose he took a Leyden flask filled with air, the degree of the oxygenation of which he had previously ascertained by an eudiometer, and electrified it as strongly as possible: he then let it stand a few hours, and examined the air again; he, however, found neither absorption nor dilatation to have taken place: and the case was the same when he exposed the jar to abundance of sparks; from which it appears, that the quality of the air is not changed by electricity.

He then electrified a jar closely stopped, through the cover of which a bent glass tube proceeded downwards parallel to the side of the jar, and the exterior part of the tube was placed in a small vessel filled with water. He charged this jar positively and negatively. Had the positive electricity occupied that space which the air before occupied, the water must have sunk in the tube; and had this space been lessened by the negative electricity, the water must have risen in the tube. As neither of these was the case, the electric matter must pass through the interstices of the air without causing a farther separation of its component parts; and that matter also which goes out in electrifying negatively, must be contained merely in the interstices, without occasioning any alteration in the particles of the air.

X. *Observations and Experiments on Staining Wood.* By
 Professor BECKMANN. From New Transactions of the
 Royal Society of Göttingen, Vol. VI.

THE oldest inlaid works now extant are preserved in Italy, and the most highly esteemed of these are those made by John of Verona, a monk and cotemporary of Raphael, who was born in 1470, and died in 1537. He was invited to Rome by Pope Julius II. in order that he might add to the splendour and magnificence of the Vatican; and he left behind him many specimens of his art at Sienna, Naples, and other Italian cities. The works of this artist, on account of the variety and beauty of the stained pieces of wood employed in them, are still celebrated among connoisseurs, and preferred to all new works of the like kind. It is, however, to be lamented, that the processes used by John of Verona are at present altogether unknown, though the wood he employed was chiefly of European growth. Veneered or inlaid works are now so much in vogue, that there are few houses in which some of the furniture is not ornamented in this manner; and the sums of money expended every year for different kinds of foreign wood, necessary to supply this luxury, is very considerable. These woods are imported chiefly from India by the English, Dutch and French; and some of them are of more value than the best copper, the filings of which might be employed to make imitations of them. That narrow district alone on the Rhine between Darmstadt and Heidelberg receives annually for wallnut-tree wood the sum of 10,000 florins. Since mahogany furniture however began to be used, our cabinet-makers have made scarcely any thing else than common works, because we are accustomed to purchase from the English, not only the materials, but also the works themselves; so that the time may come when no workmen of this kind will be found in Germany: on that account, it is well worth the trouble to make
 expe-

experiments on the staining of our own wood, in order to render them equal, if not to all foreign woods, at least to some of them, since many things can be coloured in that manner which are harder and more compact than wood. The labours of Du Fay in this respect are well known; and it appears by some papers of his among the Memoirs of the Academy of Sciences, that rock crystal, when exposed to the vapour of arsenic and antimony, assumes a red colour. Count de Borch's description of the method of staining marble in Italy may also be mentioned; and the process by means of the smoke of oak chips, which is employed by the Dutch for colouring their tiles and earthen-ware. Canes are prepared for use in India, by dipping them in quicklime. That hard compact wood brought from America, and particularly Guiana, which, on account of its variegated and spotted appearance, is called *Bois de Lettres*, and which Aublet, who gives it the name of *Piratinera Guianensis*, much admired; has its whole surface stained by the Indians with the blackest and most durable colours.—As the art of staining wood seems at present to be nearly lost, the following experiments may be of some utility to artists :

I. *By Means of Oils and Acids.*

Exp. I. A square piece of plane-tree wood, a line in thickness, was put into pounded dragon's blood from the Canaries * mixed with oil of turpentine, and placed over the fire in a glass vessel. The wood slowly assumed the colour, even before the spirit was volatilised. After more than an hour the vessel was taken from the fire and suffered to stand the whole night, when the wood appeared of a mahogany colour, not merely on the surface, but also in the interior parts. The denser fibres were somewhat less coloured, but this, instead of injuring the beauty of the wood, rather added to it. The red dye can be made stronger or weaker by taking a greater or less quantity of dragon's blood, and by a greater

* That from Madagascar is of an inferior quality.

or less degree of digestion and boiling. The wood of the plane-tree was chosen for this purpose, because it can be easily fawn and polished; because it has a white colour; is neither too hard nor too soft; because it neither contracts nor warps; has beautiful white spots with veins that cross each other; and because artists who make inlaid work have long attempted to colour it by staining. The wood, when stained, can very easily be freed from the dragon's blood adhering to it, by means of rectified spirit of wine. The spirit of turpentine makes the wood more compact, and renders it more susceptible of a fine polish.

II. Gamboge, dissolved in spirit of turpentine, gave to the whole surface of a small piece of wood a most beautiful shining golden yellow colour. The fibres and veins, on the other hand, had assumed a colour inclining a little to red. A piece of the wood of the pear-tree assumed a darker colour, somewhat approaching to green, and which in part was nearly an olive colour. Different colours may therefore be obtained by employing different kinds of wood.

III. One part of dragon's blood, two parts of gamboge, with spirit of turpentine, gave to the wood of the plane-tree or beech, according to the mixture of the colours and the nature of the wood, a remarkable variation of dyes. A bit of beech wood seemed always to assume a blackish yellow colour; and was thoroughly stained, when moderate heat was kept up for a sufficient length of time.

IV. Distilled verdigris (crystallised acetite of copper) could not easily be used in the above manner, as its colour is too much changed by oil and fire, as is known to those who employ it as a pigment. The olive colour also does not penetrate to the interior part of the wood.

2. By Means of Spirit of Wine.

EXP. I. When dragon's blood and gamboge were merely dissolved in spirit of wine, the extract was not sufficiently strong, and the dye was of no use. The process, however,

succeeds

succeeds when the spirit of wine has been long boiled over a slow fire till it is almost evaporated. The piece of wood appears then of a dark red colour, which is improved if the wood be washed in pure spirit of wine. But the colour is never so bright as that produced by means of an oil.

II. Gamboge with spirit of wine gave to wood in this manner a yellow, and gamboge and dragon's blood a yellowish red, colour.

3. *Experiment with Wax.*

White wood boiled in spirit of wine, to which, when it began to boil, wax was added, could not be made to assume the green or the red dye, even in its small cross veins, which were exceedingly porous.

4. *Experiments with dissolved Salts and Metals.*

The following experiments with these substances, which have already been described by Macquer, seemed to be most successful.

EXP. I. A solution of common alum (sulphat of alumine) penetrates exceedingly well into wood which has been digested in it; so that hopes may be entertained of some thing being effected by it, as the white colour of every kind of wood becomes whiter by solutions of saline substances: this may be of great use to artists.

II. Wood soaked in a solution of gold assumed a red colour, but the inner part was only of a yellowish red.

III. Distilled verdigris dissolved in vinegar stained wood green, but the colour could never be brought to a grass green.

IV. Wood which has lain a long time under water becomes black, as experience shews, and looks as if charred. It, however, loses none of its toughness or compactness; and many trees dug up in Holland from the turf earth are employed there for ship-building. This effect of the sulphuric acid on wood gave occasion to the following experiment.

Pieces

Pieces of different kinds of wood, of considerable thickness, were placed in the fulphurous acid. In half an hour the whole surface of them was covered with a yellowish scurf, and the wood itself had the appearance of being charred. When washed in water, and exposed some hours to the open air, it was observed that the black colour had penetrated still farther, that the interior part only retained the natural colour, and that the wood was exceedingly close and compact. After this wood had been several times rubbed over with the oil or spirit of turpentine, it became harder and firmer, so that it could receive the highest polish; by which means the colour was rendered more agreeable. This process may be readily employed by artists, as it is easy, and does not require much expence.

V. Another black dye for staining wood, which succeeds extremely well, and may lead to other useful experiments, is that formed with liver of sulphur (sulphuret of potash) and metallic solutions. As the sulphurized hydrogen gas is so subtle that it penetrates the closest bodies, it might readily be conjectured that it would easily give a black colour to wood, if the latter could any how be made to imbibe it with a metallic solution. Pieces of different kinds of wood were placed, for several days successively, in a solution of acetite of lead, and a solution of silver, copper, iron, and other metals; after which a solution of arsenical liver of sulphur was prepared in the following manner: One part of the arsenical liver of sulphur was mixed with two parts of clear quicklime, in a porcelain vessel, over which was poured six or eight parts of boiling water. The solution was then poured off, and the wood which had been impregnated with the above metallic solutions being placed in it and suffered to remain several days, the vessel being closely shut, it assumed a black colour. The solution of acetite of lead produced the greatest effect; that of silver next, and those of the other metals least of all. Spotted wood, and particularly that of the plane, beech and pear-tree, assumed the best colour.

It is therefore beyond all doubt that porous wood, such as that of the lime, the elder, &c. could be stained much easier. Though the arsenical liver of sulphur from lime may appear superfluous, as the common, which is prepared from alkaline salts and sulphur, can produce the same effect, the above process however is that which ought to be recommended. This method of staining may be considered as the best, because it impregnates the wood with metallic particles, gives it a hardness susceptible of a fine polish, and secures it from worms. The vessel employed for this purpose must be either of porcelain, stone ware, or glass.

XI. *Description of a new Diving Machine, proper for being employed in Rivers, &c. By C. H. KLINGERT. Extracted from the Author's Account of it, published at Breslau.*

FOR several centuries mankind have employed their ingenuity to devise means by which they might descend into the water, without danger, in order to search for sunk bodies; but all the inventions hitherto made for this purpose have never fully answered the proposed end, as they have all been attended with inconveniences. Of these inventions the best known is the diving-bell; but if a man descends in such a machine to a certain depth under water, the air being condensed in the bell in proportion as the height of the column of water of equal diameter becomes greater, he can breathe only for a short time; and the very nature of the machine prevents him from moving about at pleasure, which is an object of the utmost importance. A desire to obviate these difficulties induced the author to contrive a machine in which a man could not only rise and descend at pleasure, but even at the depth of from 20 to 60 feet and more under water, walk, breathe, and move freely; and he was so far successful that an experiment made with his

his machine in the river Oder, in the presence of a great many spectators, exceeded what could have been expected.

It is well known, that the pressure of water increases with its depth; and as water is a dense body, a man cannot descend far in it without experiencing a very strong pressure: so that if a diver, whose head is five feet below the surface, attempts to breathe through a pipe, he finds himself incapable of inhaling the air, on account of the pressure he sustains on his breast. A man, therefore, to descend to a great depth, must have his body and breast free from the external pressure of the fluid. In order to secure him from this inconvenience, the author has invented a sort of harness, made of strong tin plate, in the form of a cylinder, which goes over the diver's head, and which consists of two parts, that he may conveniently thrust his arms through it and put it on; also a jacket with short sleeves, and drawers of strong leather. All these being water-tight, and closely joined round the body of the diver, secure every part of him but the arms and legs from the pressure of the water, which at the depth of 20 feet will occasion no inconvenience to these parts.

Fig. 1 (*Plate 1*) represents the diver covered with the harness, jacket and drawers.

Fig. 2 is the upper part of the cylinder, the diameter of which is equal to the breadth of a man at the top of the hipbone. It is 15 inches in height, has a globular top, and is made of the strongest tin-plate.

In the inside of the cylinder, at *a*, is a strong broad iron hoop, to enable it to withstand better the pressure of the water; and in the inside of the top there are two pieces of a strong hoop of the same kind, placed over each other in the form of a cross at *b*. A strong ring of brass wire is soldered upon the outside at *c*, that the jacket may be fastened to it with an elastic bandage to prevent it from slipping downwards. At *d d* are the upper halves of the apertures for the arms; and *e e* are holes to afford light, and into which the eye glasses are screwed; *f* is the opening
into

into which the mouth-piece of the breathing pipe is screwed; and *g* is an aperture for looking through, as well as for the purpose of breathing when out of the water, and which, by means of the cover *b* suspended from it, can be screwed up before the diver enters the water.

Fig. 3 represents the under part of the cylinder, which is also 15 inches in height, and which at *i* and *k* is strengthened by iron hoops on the inside, in the same manner as the former. To the lower hoop *k* are foldered four small rings, to which are fastened strong leather straps, three inches in breadth, that can be buckled cross-wise over the shoulders, and support the whole machine; *ll* are the under halves of the apertures for the arms; *m* is also a ring of brass wire foldered to the cylinder, which serves to keep fast the jacket when buckled on, and to support the upper cylinder (*fig. 2*) which slips over the under one, and on that account the under one is a little smaller so as to fit into the upper one. There is also another such ring at *n*, in order to prevent the drawers from falling down.

At *o* (*fig. 2*, and *fig. 6*) is a strong semicircular piece of iron, the use of which is to prevent the drawers, when pressed by the water, from touching the under part of the body, otherwise the pressure, even at the depth of six feet, would be insupportable. As it is not possible to sew the leather so closely as to prevent water from forcing its way through the seams, a small pump is suspended at *p*, for the purpose of pumping out the water when it has risen to the height of a few inches in the lower cylinder. Four hooks *q q q q* foldered to the lower part of the cylinder are for the purpose of suspending weights from them.

The jacket *r* (*fig. 1*) with short sleeves that cover the upper part of the arms, serves to prevent the water from penetrating through the joining of the cylinders, where the one is inserted into the other, as also through the holes for the arms, as it is bound fast round both parts of the cylinder
and

and likewise round the arms. The case is the same with the drawers, which are bound close round the knees.

Fig. 4 represents a brass elastic bandage, employed for fastening on the jacket, and which, when hooked together, is screwed fast by means of the screw *f*, three inches in length. A brass bandage is here used, because leather is apt to stretch, and on that account might be dangerous.

Fig. 5 is the mouth-piece to which the pipes *x y* are fastened, and which is screwed on at *f* (*fig. 2*); *t* is the screw; *u* the part that goes into the machine, and which is taken into the mouth; *v* the exterior part of it, in which there is a partition *w* in order to separate the pipes; and *z* is an aperture, that the air in the machine may communicate with the pipe *y*.

The internal diameter of these tubes is three fourths of an inch Rhinlandish. They consist of strong brass wire $1\frac{1}{2}$ line in thickness, wound into a spiral form, and covered with strong leather. In order to save expence, six yards of the pipe, from the mouth-piece, may be made in this manner, and the rest of tubes of tin-plate three or four yards in length, joined together with pieces of leather-pipe about a foot in length, prepared in the first manner.

The reservoir *a* (*fig. 1*), applied in such a manner that it can be screwed off, is for the purpose of collecting the small quantity of water that might force itself into the breathing pipe when long used, and which otherwise would be in continual motion and render breathing disagreeable.

To prevent the leather from becoming hard, and to close up its pores, so that it may be rendered water-tight, the following mixture was rubbed over it: viz. 6 parts of wax, 2 of Venetian turpentine, 2 of pitch, and 2 of melted hogslard. It is also to be observed, that the best and strongest leather must be used for the tubes, and that stripes of leather must be sewed very closely on the seams of the jacket and drawers.

If the machine be intended for diving to a great depth, it must be constructed in as strong a manner as possible, and the drawers must be furnished with iron ribs in the inside fastened by means of hoops to the machine, as may be seen fig. 3 and 6, over which a net of small chains or strong cords must be hooked or tied to the hoop *k*, and also to the hoops 2, 2, 2, 2, by means of the holes made in them for that purpose; but these chains or cords in particular which go behind must not be drawn too tight, that the diver may be able to bend his body.

The ribs 1, 1, are screwed on the inside to the strong iron hoop *k*, but in such a manner as to be moveable; and as the centres rest on the hips, the diver can move his legs backwards and forwards. To these ribs the two hoops 2, 2, are made fast by riveting at 3, 3, and the two interior ribs 4, 5—4, 5 are fastened in the like manner. To the latter must be soldered at 5, 5, a circular piece 6, 6, 6, of the like radius as the part *o*, which, as the diver walks, moves backwards and forwards on *o* by means of a groove, at the same time that the outer ribs move; and on account of these ribs, hoops, &c. the pressure of the water upwards will present the less impediment to the diver, as it can act only according to the diameter of the smallest hoops 3, 4—3, 4.

The author gives the following instructions for using a machine of this kind. When the diver, after being made acquainted with all the parts of the machine, has put it on and suspended from it the proper weights, let him enter the water at any convenient place, and advance till it reaches to his eyes, while the end of the pipe is held by a person on the bank. If the diver can then breathe with ease, and if no water forces itself into the pipe, which must be left to float on the water, he may proceed till it covers his head, having first taken the precaution to tie a strong rope to one of his arms. After this he may stop for some time, and then gradually go deeper and deeper, making signals that he finds himself at ease, by pulling the rope, or by speaking through

the pipe. If a man exercises himself in this manner for several days successively, still increasing his depth, he will soon be able to dive boldly, and to move under the water with ease and freedom : when he wishes to ascend, he needs only unhook the weight, which will drop to the bottom; and being then lighter than an equal volume of water, he will rise to the surface. To preserve the weight from being lost, a particular rope must be employed, which may be let down to the diver upon his making a certain signal, and which he may fasten to the weight before he unhooks it.

By following these directions a resolute man may be taught, in the course of a few days, to dive to a moderate depth, though on account of various preparations and unforeseen difficulties, the author employed five whole weeks in teaching one who was unacquainted with swimming. This man, called Frederick William Joachim, a huntsman by profession, dived in the above apparatus into the Oder, near Breslau, where the water was of considerable depth and the current strong, on the 24th of June 1797, before a great number of spectators, and sawed through the trunk of a tree which was lying at the bottom. He shewed also that he could have fastened sunk bodies to a rope in order to be drawn up, and that in case any impediments should prevent the use of the saw, such trunks might be hewn to pieces by an axe. It clearly appears, therefore, that two men furnished with such apparatus could saw to pieces large beams of wood lying at the bottom of rivers, which are often a great obstruction, and, on account of their size, cannot be otherwise removed.

One part of the construction was attended with an inconvenience, which it may be proper to mention. It has been already remarked, that a man at the depth of five feet under the water cannot breathe without a machine; and though one, such as that above described, will defend his breast and body from the pressure of the water, yet though it be furnished with a pipe to breathe through, it will appear,

From what follows, that this will be impossible. The air which surrounds the diver in this machine amounts to somewhat more than a cubic foot. Now if he inhales air through the pipe screwed to the machine, his body must distend a space equal to the volume of air inhaled, consequently he compresses so much the air that surrounds him in the machine. But as this is impossible, on account of its too great resistance, he does not obtain air sufficient to support life, and is almost in the same state as if surrounded by water. To be convinced of the truth of this, let any one take a cask, equal in content to one or two cubic feet; press his mouth against the aperture of it, and try whether he can without difficulty breathe back into it the air he has inhaled. A larger space around the diver in the machine would make breathing easier, but would not render him sufficiently easy to labour. The interior air in the machine, therefore, must be connected with the pipe destined for breathing, in order that it may be at freedom to dilate as his body is extended; and it is only by a construction of this kind, as shewn at *z* in describing fig. 5, that a man can breathe while inclosed in so small a space. The author, at first, had furnished his mouth-piece with a valve, that the air might be again exhaled through it; but this valve was so ill constructed that it conveyed the exhaled air into the pipe destined for breathing. As he found that this was attended with inconvenience, on account of the moisture which adhered to it, he afterwards omitted the valve entirely.

The diver, therefore, must suffer the air inhaled through the mouth-piece *u* to escape through his nostrils into the machine; and then the air in it will remain equally elastic. The next time he draws breath, the air in the machine will be forced out from it at *z* by the distention of his body. By these means he will be able to breathe freely and easily for a long time; and thus the chief difficulty is overcome.

We cannot better conclude our account of M. Klingert's

diving machine than by recommending it to the attention of that benevolent institution which has been the mean, in the hand of Providence, of averting the tear of sorrow from the eye, and inexpressible anguish from the heart, of many individuals who daily implore that the richest blessings of Heaven may be showered down upon the HUMAN SOCIETY. The apparatus seems so well contrived in all its parts, as almost to preclude the possibility of improving it: yet there can be little doubt that by the ingenuity of British artists it might be simplified a little, and produced at so cheap a rate that the funds of the Society might be able to add such machines to their other apparatus for saving people from drowning. If such machines were deposited at the places where accidents of this kind most usually occur, and some persons in the neighbourhood instructed in the use of them, how speedily might the unhappy victim be often rescued from death! How infinitely preferable would this be to dragging, and how much more certain in its result, since the diver, when under water, could look round him for his object, and proceed directly to the spot! For such a purpose it would be advisable to make the machine so large that it would require an extra weight, more than equivalent to that of a man's body in water, to sink it: the diver, by unhooking the weight or weights, would then be enabled to ascend to the surface of the water with the patient in his arms.

XII. *Observations on Fire Balls.* By F. C. FULDA. Read in the Physical Society of Göttingen, December 7, 1796. From Professor GMELIN's Göttingisches Journal der Naturwissenschaften, Vol. I. Part 2.

NOTWITHSTANDING the great progress which the sciences have made in the present century, and though our knowledge of the atmosphere has, in particular, been much enlarged,

enlarged, we are still far from being able to explain all its phenomena, especially those of the luminous kind, in a manner sufficiently satisfactory to the cautious and reflecting philosopher. Though many, in consequence of the important discoveries made respecting the electricity of the clouds, imagine that they have found in the electric fluid, so widely diffused, a certain key to all distant phenomena of a similar kind, yet the greater part of them as mere observations, and the explanations given of them as mere hypotheses, must be left to the decision of posterity. It would be useless, and perhaps it is impossible, to mention all these phenomena in any certain order; but the most singular of them are large fire-balls (*bolides*), which, on account of their importance in natural philosophy, have in modern times excited universal attention *.

Respecting the origin and nature of these phenomena, which are but seldom seen, and always surprise us as it were accidentally, we can venture conjectures and explanations only when we have compared a series of observations carefully made with the circumstances by which they were at-

* On the 13th of July 1797, about 42 minutes after nine in the evening, I had the good fortune, when in company with several of my friends, to see a meteor of this kind. It appeared in the southern part of the horizon, at the height of 8 or 10 degrees; had the form of a perfect globe or sphere well defined at the edges, almost as large as the moon when at full, and proceeded in the space of scarcely a second, while its course was only marked by a fine white streak of light, in an almost perpendicular direction towards our horizon, which was confined by houses, and disappeared behind them. Its colour and splendour near the middle were sometimes of a dazzling white. The heat during the day, and in the evening, was considerable. The thermometer varied from 18 to 20 of Reaumur, and between the hours of four and five in the afternoon there had been a storm in the same quarter of the heavens. At the surface of the earth there was a perfect calm, and in the evening the weather-cocks shewed that a light south-west wind prevailed at some height in the atmosphere. At the time of this phenomenon the earth was overspread by a pale mist, through which no stars could be perceived, and which the following night became a thick fog.

tended, and have then deduced from them general conclusions*, which in the hands of the mathematician may conduct with the greatest certainty to a knowledge of their nature, and of the causes by which they are produced. I shall endeavour, therefore, to present the reader with such conclusions drawn from a series of observations made in regard to fire-balls, not with the intention of giving any explanation from them myself, but in compliance with the excellent rule laid down by Le Roy, when he says, speaking of this circumstance: “Let us always collect observations without being too forward to deduce consequences from them, and to explain phenomena respecting which we have at present so little knowledge †.

Some of the observations here given, as well as the conclusions drawn from them, have been already employed by Dr. Chladni, in a particular treatise ‡ to explain the origin of the mass of iron found by Professor Pallas in Siberia §, and other masses of the like kind, as well as stones which, according to accounts worthy of credit, are said to have fallen from the heavens, and therefore more in a geological than a meteorological view. My object is quite different. I propose, notwithstanding the difficulty of determining properly from the observations made to what class of luminous appearances such phenomena belong ||, to collect together those accounts which have been considered, at least with some proba-

* Il faudroit étudier avec soin les rapports de ces phénomènes avec les autres phénomènes atmosphériques; rechercher l'état du ciel avant et après leur apparition, déterminer les tems, les circonstances et lieux où ils sont les plus communs, savoir pourquoi ils sont rares, et pourquoi ils arrivent. Que d'observations à faire! Que d'observateurs à occuper! — *Sennebier*.

† *Memoires de l'Academie des Sciences*, 1771.

‡ Ueber den Ursprung der von Pallas gefundenen und anderer ihr ähnlichen Eisen-Massen, von C. F. F. Chladni. Riga 1794.

§ See *Philosophical Magazine*, Vol. II. p. 1.

|| Henry Barham, as mentioned in the *Philosophical Transactions*, vol. XXX. p. 337, saw in Jamaica, in the year 1700, a flaming fire-ball, of the

probability, as alluding to the same kind, and in most cases just as they were given by the observers, without paying attention to any particular mode of explanation, in order to assist those whose attention is occupied with the origin and nature of these bodies, to examine the old and new hypotheses formed respecting them, or to support future ones, if necessary. These meteors appear, then,

1. In every climate. Of fifty observations with which I am acquainted, three were made immediately under the equator*; three in a southern†, and 44 in a northern latitude: and this disproportion arises merely from the greater number of accounts brought to us from the latter, and the greater attention of the observers; for we are assured by Forster, that he saw several fire-balls in the south seas‡.

2. At every season of the year. I am acquainted with observations made in every month except September; and of these several were made, but between the 45th and 55th degree of northern latitude, in all the months except April,

size of a bomb, descend towards the earth; but though the ground was dug up around the place where it seemed to fall, nothing could be perceived except burnt grass and a sulphureous smell. A violent storm, it is said, had taken place a little before, which makes it highly probable that this phenomenon was nothing else than lightning, especially as Reimarus relates, that lightning has been seen to fall upon houses and conductors in a globular form, and that a sulphureous smell has been afterwards perceived: see *Reimarus vom Blitz*, Hamburg 1794, p. 51, 155, 319. An observation of two balls proceeding towards each other before a thunder cloud, made by Hartman, in July 1758, seems to be of the like kind. See *Verwandschaft der Elektrischen Kraft mit den Lusterscheinungen*, Hanover 1759, p. 237; and also a flash of lightning mentioned by Reimarus, p. 12. Other instances of the two phenomena being confounded, are noticed by Dr. Chladni in his work, p. 2.

* Ulloa's Voyage to South America. Lond. 1760. Vol. i. p. 354, and vol. ii. p. 226.

† Journal des Observations Physiques, Mathematiques et Botaniques, par Louis Feuillé. Paris 1714. Vol. i. p. 116, 119. and vol. iii. p. 92.

‡ Forster's Observations, made during a voyage round the world, on Physical Geography, &c. p. 119.

June and September. It cannot, therefore, be said that, like storms, they appear more frequently at one time of the year than another.

3. At every period of the day. The hour when these phenomena took place is not indeed given by every observer, but observations have been made both by night and by day. The greater part, however, have been made in the evening, when, being more perceptible to the eye, it was less possible for them to escape notice.

4. They appear, for the most part, when the sky is serene. This remark is expressly made in regard to 26 of the above mentioned 50; and in regard to the rest it is to be concluded from concomitant circumstances, such as their height, &c. The heavens were often covered only with a pale mist*, and some few were seen to proceed from light clouds†, which gives us reason to suppose that they came from a greater height than these clouds.

5. Most of them were seen to move with a very rapid motion, and of those on the velocity of which observations have been made; that is said to have moved quickest which was seen in the month of November 1758, and which, according to the calculation of Sir John Pringle‡, passed over thirty English or seven German miles in one second; a velocity greater by $3\frac{1}{2}$ miles in a second, than that of the motion of the earth in its orbit. The one said to have moved slowest is that which was seen by Balbus at Bologna, in the month of March 1719§, and which proceeded, according to his reckoning, at about 1530 feet or 0,067 of a German mile in one second. But there is reason to conclude

* *Breslauer Sammlungen von Natur-und Medicin-Geschichten.* III. Jan. 1716, p. 544. *Hanov. Magazin* 1791, p. 1628.

† *Breslauer Sammlungen* xxix. Aug. 1724, p. 169. Compare *Lichtenbergs Gothaisches Magazin*, vol. iii. part 2. p. 92; vol. iv. part 2, p. 164.

‡ *Philosoph. Transactions*, vol. li. part 1. p. 218.

§ *De Bonon. Scient. Instit. Comment.* vol. i. p. 285.

that the movement of others*, the course of which, as might be conjectured from their long train, was not in the direction of the eye, must have been much slower. Some appear also, unless these be refused a place here, to be peculiar to one part of the heavens†.

6. They proceed from, as well as towards, all points of the compass. The greater part of them, however, have beyond all dispute appeared in the northern or southern parts of the horizon; but no general conclusion, in regard to their connection with the northern‡ or southern lights, can be drawn from this circumstance, though some observations made in Sweden§ seem to favour such an hypothesis.

7. They do not always move according to the direction of the wind. The third observed by Ulloa makes, perhaps accidentally, an exception; and the spindle-shaped meteor seen by M. Lichtenberg, at Gottingen, on the 12th of November||, was towards the S. S. E. the then direction of the wind, which however near the earth was very little felt. Besides, their velocity was seldom or never proportioned to that of the wind; as during the most violent storm it does not move above 100 feet per second. When such meteors have appeared, it has been generally calm; but some of them were followed by wind¶, and Forster observed that after each fire-ball which he saw a violent wind took place.

* Breslauer Sammlungen, iv. May 1718, p. 1077; Philosoph. Transactions, vol. xliii. No. 477, p. 524; and Gothaïsches Magazin, vol. iv. part 2. p. 164.

† Hof in Acta Litteraria et Scient. Sueciæ, an. 1734, p. 78; and De Genffance in Histoire de l'Acad. des Sciences. Paris 1738. p. 36.

‡ Bergman's Physic. Beschreibung der erdkugel, vol. ii. p. 78. Bernstoff in Rozier's Journal de Physique, 1784, p. 115; and Blagden in the Philosoph. Transactions for 1784, p. 229.

§ Hof and Celsius in Acta Litteraria et Scient. Sueciæ, an. 1734, p. 78 and 81. Giffler in Schwedische Abhandlungen, vol. xxv. p. 65.

|| Hannövrifches Magazin, 1791, p. 1626.

¶ Acta Litteraria Sueciæ, 1734, p. 78; and Chladni in Gothaïsches Magazin, vol. xi. part 2. p. 112.

8. They almost all fell towards the earth, and consequently from a rarer to a denser atmosphere, as in most cases might be concluded from their soon becoming considerably enlarged. Some of them, however, particularly those which moved slowly, seemed to proceed in a horizontal direction over the surface of the earth; but none of them, according to every appearance, moved upwards. Their motion, therefore, cannot be explained in the same manner as that of sky-rockets*, where the superior air is rarified by the flame, and that below condensed.

9. Their form was sometimes perfectly globular, and sometimes more spindle shaped; so that their length often occupied seven or eight degrees of the heavens. When observed to move with great velocity, they had a long tail behind, which arose chiefly from the continuance of the impression made on the eye†. Others, however‡, and particularly those which moved slowly, shewed that a part of the tail belonged to the body itself; and it would appear that the long train which marks their course, ought often to be explained rather by traces left behind them than by mere impression§.

10. Their apparent magnitude was very different, but on several occasions greater than that of the moon||.

* *Gothaisches Magazin*, vol. iii. part 2. p. 95.

† *Intelligimus magis qua appareat stella, quam qua eat. Itaque velut igne continuo totum iter signat, quia visus nostri tarditas non subsequitur momenta currentis, sed videt simul et unde exsilierit et quo pervenerit. Quod fit in fulmine, longus nobis videtur ignis ejus, quia cito spatium suum transilit, et oculis nostris occurrit universum, per quod dejectus est. At ille non est extenti corporis per omne qua venit. Senecæ Quest. Natur. lib. i. cap. xiv.*

‡ Robinson in the *Philosoph. Transactions* for 1784, part i. p. 225.

§ *Breslauer Sammlungen*, i. 1717. p. 157; *Philosoph. Transactions*, vol. xli. part 2. p. 870, vol. xlii. p. 1; and *Transactions of the American Philosoph. Society*, vol. ii. p. 173.

|| *Histoire de l'Acad. des Sciences. Paris 1761. p. 28. Gothaisches Magazin*, vol. iii. part ii. p. 92.

11. Only a few of them had an apparent motion round their axes*.

12. The greater part of them diffused a very lively dazzling light†; the fewer number a faint light. Their colour and splendour were very different and variable; sometimes red, sometimes blue, sometimes violet, sometimes in part yellow or dazzling white, and some exhibited the prismatic colours‡. Several have been seen to burn with a bright flame, and others as if in a state of ignition.

13. Their real diameter, as far as could be ascertained, sometimes by conjecture and sometimes by actual measurement, was always very considerable. The diameter of that respecting which Sir John Pringle made calculations from various observations he collected, and of that seen by Mr. Rittenhouse § at Philadelphia, in the month of October 1779, were at most about half a German mile.

14. They seem to have originated at a very different, though most of them at a very considerable height above the surface of the earth. At any rate all of them, whose mean or greatest height was subjected to any calculation, exceeded that of the highest clouds, as clouds are scarcely perceptible at the height of 13,500 toises; and Silberschlag found the greatest height of the fire-ball, which appeared in July 1762, to be 19 German miles, or 72,276 toises. On this account their origin, as Reimarus and Chladni have already sufficiently shewn, is not to be ascribed merely to electricity, though some have considered them as occasioned by the action of the electric fluid between the clouds and the northern lights, which would agree exceedingly well with

* Nova Acta Nat. Curios. vol. i. p. 348. Theorie der am 23 sten. Jul. 1762 erschienenen Feuerkugel von J. E. Silberschlag. Magd. Stend. u. Leipz. 1764. 4.

† Philosoph. Transactions, vol. xli. part 1. p. 346.

‡ Gothaisches Magazin, vol. iv. part 2. p. 164. Hannövrifches Magazin, 1791, p. 1627.

§ Transactions of the American Philosoph. Society, vol. ii. p. 175.

their actual height; as, according to the measurement of Bergman, Kastner and Lambert*, the northern lights have an altitude of more than 20 or 30 German miles, and according to every appearance no fire-balls have been seen higher. On the other hand, this general conclusion led Halley †, Franklin ‡, and Rittenhouse §, to the grand idea, which Dr. Chladni has defended with so much ingenuity, that these phenomena, as well as shooting stars, are cosmical meteors belonging to the atmosphere of the sun, which meeting our earth in its course round that luminary are inflamed, by some cause or other, when they enter the earth's atmosphere. The phenomenon also seen by De Genffance at Paris in the month of July 1738, and the like observation of falling stars on the highest mountains, as well as on the surface of the sea ||, but in particular the new distant luminous phenomenon observed by M. Schroter ¶, will appear the more favourable to this hypothesis, as we have reason to suppose that there are processes carried on in our atmosphere with which we are as little acquainted as with those carried on in the interior parts of the earth.

15. The time of their duration was very different: that observed by De Genffance continued half an hour; at other times their duration has seldom been above a minute. Few or none of them, however, have been observed from the commencement of their appearance till the time when they disappeared.

16. Many of them in their course threw out sparks, and the greater part of them were seen to divide themselves into several, sometimes larger, sometimes smaller parts, before they

* Göttingischer Taschen-Calendar, 1778, p. 52.

† Philosoph. Transactions, No. 341.

‡ Gothaïsches Magazin, vol. iv. part 2. p. 114; and vol. ix. part 3. p. 173.

§ Transactions of the American Philosoph. Society, vol. ii. p. 175.

|| Brydone in the Philosoph. Transactions, vol. lxxiii. part 1. p. 167.

¶ Gothaïsches Magazin, vol. xi. part 1. p. 86.

entirely disappeared. This division also seems to oppose the hypothesis of a tract of inflammable air set on fire*, which Dr. Chladni has sufficiently refuted on other grounds,

17. This bursting into pieces was for the most part accompanied with a rumbling noise like thunder, or a sudden report. This was observed to be the case in regard to 27 of the 50 above mentioned; and very often two or more reports have been heard in succession, without the large ball being divided into smaller ones, and without these being still farther shattered. But as these reports were heard at a very great distance †, and as many which did not appear to be more remote, but nearer, have burst without any report; a question arises, whether we are to consider, as Dr. Chladni does, this violent bursting as peculiar to all these phenomena?

18. Several, after bursting, seemed to dissolve into smoke ‡, and, according to the observation made by Celsius in the month of March 1731, a visible smoking stripe seemed to be previously inflamed. The greater part of them, however, after exploding, left no visible traces behind.

19. In some cases, after their disappearance, a sulphureous smell was perceived §, like that perceived after lightning has fallen, and which gave occasion to Muschenbroek's hypothesis of an accumulation of sulphureous inflammable vapours that arise from volcanoes and subterranean pits, and being driven together by the winds form clouds, that by some accident or other are set on fire; but which, however, can as little be reconciled with their general prodigious height, as Silber-schlag's oily and slimy vapours.

* Gehlers *Phyf. Wörterbuch*, art. *Feuerkugel*.

† *Allgem. Historie der Reisen*, vol. ix. p. 564; and *Philosoph. Transactions*, vol. iii. part 1. p. 163.

‡ De Bonon. *Scient. Institut. Comment.* vol. i. p. 285; *Philosoph. Transactions*, vol. xli. part 2. p. 870, vol. xlii. p. 1; and *Hist. de l'Acad. des Sciences*, Paris 1753, p. 73.

§ *Breslauer Sammlungen*, i. p. 157; *Philosoph. Transactions*, vol. 1. p. 299; and *Goth. Magazin*, vol. xi. part 2. p. 112.

20. As scoriaceous masses have frequently been either actually seen to fall at the time of the disappearance of these phenomena, or have been found soon after on the surface of the earth, and as it is sufficiently proved by various accounts that stones have fallen from the atmosphere, Dr. Chladni concludes that both these phenomena are connected; but this can be determined only by future accurate observations.

XIII. *A Communication from Mr. W. H. PEPYS jun. Member of the London Philosophical Society, containing an Account of some interesting Experiments on the Production of Artificial Cold, in one of which Fifty-six Pounds of Mercury was frozen into a solid Mass.*

THE freezing or fixing of mercury has been the means of proving it to be a metal possessing the principal properties and characteristics of other metals, as splendour, malleability, and a crystallised structure when reduced to a solid form. Gmelin was the first who ever observed mercury at such a low temperature as leads to a belief that a partial congelation had taken place, though he did not then suspect the fact; but “De L’Isle was probably the first person upon earth who saw quicksilver reduced to a solid form by cold, and ventured to credit the testimony of his senses*.” This happened at Yakutsk in Siberia, in 1736, where the natural temperature was so low at the time as to produce the effect without the aid of artificial means.

Since that period the production of artificial cold, by means of various mixtures, sufficiently intense to freeze mercury, has employed the abilities of the most experienced chemists and philosophers, as Braun, Blumenbach, Hutchins, Lambert Bicker, Fothergill, Cazalet, Guthrie, Caven-

* See Dr. Blagden’s paper on this subject in the Phil. Transactions for 1783.

fish, &c. and latterly Walker, who, in his treatise on that subject, seemed to have exhausted the whole train of mixtures, and certainly has shewn considerable ingenuity in the contrivance of the instruments and apparatus he employed to accomplish the end he had in view: but, though I am possessed of the principal part of them, and repeated his experiments with the greatest care and attention, I cannot say I succeeded in all of them. The materials employed by Seguin for frigorific mixtures are certainly the best that have yet been proposed, or perhaps can possibly be devised. Considering the muriats as a class of salts best suited for the purpose, and having tried them all, he gave the decided preference to muriat of lime in crystals. His method was to mix the crystals, previously pulverised, with an equal weight of uncompressed snow. My friends Allen and Lawson were, I believe, the first who in this country tried that method: this was in December last; and they succeeded perfectly in freezing the mercury.

Determining to make the experiment with accuracy in respect to the weight of the materials employed, and on such a scale that it might be repeated by any one, on the 30th of January last we collected a quantity of snow for the purpose. The temperature of the laboratory at the time was 40° . It may not be improper to mention here, that the thermometer employed in this and the other experiments which followed was filled with tinged alkohol, and accurately divided according to Fahr. scale, as mercurial thermometers cannot be resorted to for determining degrees of temperature at or under the freezing point of that metal. Having put into an earthen pan equal parts of muriat of lime of the temperature of 40° and snow at 32° above 0° , we found that the temperature of the mixture, as soon as liquefaction took place, was 32° below 0° . Into this mixture we immersed, each in separate vessels, 8 oz. troy of muriat of lime, and the same weight of snow, by which means, and with very little trouble, they were cooled down to 5° above 0° , the mixture
gaining

gaining a proportionate increase of temperature by the heat which had passed into it from the immersed snow and muriat.

We now placed a half-pint Wedgewood's cup within a white stone-ware jar, insulating it, agreeably to a method suggested by our friend Howard, with three corks placed at equal distances round the vessel, and one at the bottom for the cup to rest upon. This prevented the cup from coming in contact with the jar, which we now placed, with the cup in it, in the mixture that had served for cooling the materials down to $+ 5^{\circ}$ *, adding to the mixture a little more muriat of lime at $+ 40^{\circ}$ and snow at $+ 32^{\circ}$. By this means we secured the advantage of having a cold atmosphere within the jar all round the insulated cup.

Upon mixing the cooled ingredients, which were now put into the cup, the thermometer, being immersed in the mixture, sunk to $- 50^{\circ}$. Four ounces of pure mercury at $+ 40^{\circ}$, in a small thin glass retort, were then introduced into this mixture, which in 15 minutes became perfectly fixed. We observed that it congealed from the circumference towards the centre, in the same way as wax or resin fixes in cooling.

We now broke the retort, and gave the mercury several blows with the beak of a hammer, which indented, and at last fractured it: the fracture was similar to that of zink, but with facets more cubical. Inadvertently taking up a piece of the solid mercury, I experienced a sensation as if I had received a wound from a rough-edged instrument. I threw it from me as I would have done a piece of red-hot iron, and was not a little alarmed when I found that the part of my hand which had been in contact with the metal, immediately after lost all sensation, and became white and dead to the view.

The mercury in the mean time had become fluid. The time that had passed from taking it out of the mixture might

* The sign $+$ denotes above, and the sign $-$ below 0° .

have been about two minutes; but the accident that happened to my hand prevented me from noting it exactly. On trying the temperature of the mixture, I now found it -42° : the addition of some snow, which had been cooled for the purpose while the preceding experiment was going on, reduced it again to -50° .

We now put into the mixture a glass tube containing some mercury. In two minutes it was completely fixed. We broke the tube, and bent the cylindrical piece of mercury into an acute angle, by means of pincers: we attempted to straiten it again, but it became fluid during the operation.

Several substances in proper vessels were now tried in the cold mixture. Sulphuric ether exhibited no signs of congelation: rectified spirit of turpentine became thick and nearly consistent at -50° : pure concentrated sulphuric acid was fixed: acetic acid likewise was fixed: nitric acid became thick and ropy. On muriatic acid the cold had no effect.

On the 7th of this month (Feb.) we repeated our experiment, in the presence of a number of our acquaintance, with the same success as before.

Encouraged by the success of these experiments, we resolved to attempt one of some magnitude. Accordingly, on the following day, my friend Allen, who is a zealous and able chemist, started a bullion of mercury for the purpose; and, having weighed 56 lbs. avoirdupoise, we prepared every thing necessary for fixing this quantity.

The mercury was put into a strong bladder and well secured at the mouth, the temperature of the laboratory at the time being $+33^{\circ}$. A mixture consisting of muriat of lime 2 lib. at $+33^{\circ}$ and the same weight of snow at $+32^{\circ}$ gave -42° . The mercury was put as gently as possible into this mixture (to prevent a rupture of the bladder), by means of a cloth held at the four corners. When the cold mixture had robbed the mercury of so much of its heat as to have its own temperature thereby raised from -42° to $+5$, another mixture, the same in every respect as the last, was made, which

which gave, on trial with the thermometer, -43° . The mercury was now received into the cloth, and put gently into this new mixture, where it was left to be cooled still lower than before.

In the mean time five pounds of muriat of lime, in a large pail made of tinned-iron and japanned inside and outside, was placed in a cooling mixture in an earthen-ware pan. The mixture in the pan, which consisted of 4 lib. of muriat of lime and a like quantity of snow, of the same temperature as the former, in one hour reduced the 5 lib. of muriat in the pail to -15° . The mixture was then emptied out of the earthen pan, and four large corks, at proper distances, placed on its bottom, to serve as rests for the japanned pail which was now put into the pan. The corks answered the purpose already mentioned, that of insulating the inner vessel, while the exterior one kept off the surrounding atmosphere, and preserved the air between the two at a low temperature.

To the 5 lib. of muriat of lime which had been cooled as already noticed to -15° , and which still remained in the metallic vessel, was now added snow, uncompressed and free from moisture, at the usual temperature of $+32^{\circ}$. In less than three minutes the mixture gave a temperature of -62° : a degree of cold which I believe was never before produced in this country, being 94° below the freezing point of water.

The mercury, which, by immersion in the second cooling-mixture to which it was exposed, we found by this time reduced to -30° , was now, by the means employed before, cautiously put into the last-made mixture of the temperature of -62° . A hoop, with net-work fastened to its upper edge, and of such a breadth in the rim that the net-work, when loaded with the bladder of mercury, could not reach its lower edge, was at the bottom of the mixture, to prevent the bladder from coming in contact with the vessel; by which means the mercury was suspended in the middle of the mixture. As soon as the bladder was safely deposited on the net-work, the vessels were carefully covered over with

a cloth, to impede the passage of heat from the surrounding atmosphere into our materials. The condensation of moisture from the atmosphere by the agency of so low a temperature was greater than could have been expected: it floated like steam over our vessels, and, but for the interposed covering, would have given our mixture more temperature than was desirable.

After one hour and forty minutes we found, by means of a searcher introduced for the purpose, that the mercury was solid and fixed. The temperature of the mixture at this time was -46 , that is 16° higher than when the mercury was put into it.

We now regretted that we had not flung the hoop and net-work in the same way as the shell of a beam is suspended, which would have enabled us to lift it out of the mixture at once with the bladder and its contents; but having overlooked this provision, we were obliged to turn out the whole contents of the pail into a large evaporating capsule made of iron, which was not effected without the mercury striking against its bottom, and at the same time receiving a considerable increase of temperature. The bladder was now cut. The eagerness of our friends, of whom several were present, to be in possession of pieces of the solid mercury, which had fractured by the fall it had received, was past description. Forgetting, and perhaps not being aware of the consequence, some rushed their hands into the frigorific mixture, while some seized on pieces which others, having selected with their eyes as their prize, also laid hold of at the same moment, and consequently each grasped them harder than otherwise they would have done. The acute pain that instantly followed, quickly recalled their recollection, and, but for the sufferings of the individuals, the scene would have excited no small degree of mirth: some clapt their hands into their mouths, others shook them, blew on them, or rubbed them against their clothes; and all were more or less

alarmed at the dead appearance of the parts that had been so suddenly robbed of heat by the frozen metal *.

The larger pieces were kept for some minutes before fusion took place, while others were twisted and bent into various forms, to the no small gratification and surprise of those who had never witnessed or expected to see such an effect produced on so fusible a metal.

Though mercury in the state in which we had it, exhibited a considerable degree of ductility and malleability, we cannot thence infer the degree in which they would be found to belong to it, could it be reduced to a temperature much more considerably under its freezing point, which seems to be at about -39° or -40° . At the time that we bent and twisted it, it may be considered as having been in a proportionate temperature to iron near its point of fusion, when, as is well known, it will hardly bear the smallest blow of a hammer.

As the apparatus employed in these experiments was extremely simple, a short description of them may not be unacceptable. Fig. 1 (*Plate II.*) represents that employed in the first experiments; and only viewing the figure will con-

* It was a considerable time before sensation and the natural colour was restored to the parts, which however returned without any other means being employed than such as have been mentioned. It is easy to conceive that the injury was little more than skin deep, like what takes place from touching a hot metal, without allowing it to remain long enough in contact with the skin to produce a wound; but what is very singular, almost every individual compared the sudden pain he experienced to that produced by a burn or scald! One gentleman, who called accidentally while we were preparing for our experiment, but who had no acquaintance with the subject, not being able to conceive how the effect proposed could be produced by the mixture, was desired to take a little snow in one hand and muriat of lime in the other: "they were neither of them colder than he expected to find them:" then to put the snow into the hand that held the muriat. The ingredients had hardly come in contact when he threw them from him, exclaiming, "Cold!—'Tis a red-hot coal!"

vey to any one a complete idea of the arrangement, as it exhibits the retort containing the mercury, surrounded by the cooling-mixture in the half-pint cup, which is insulated by means of the corks, and prevented from coming in contact with the stone-ware jar – the space between the latter being occupied only with cold air, preserved in that state by means of the frigorific mixture in the exterior vessel, and which surrounds the jar.

Fig. 2 represents the apparatus employed in the large experiment, which is similar in its arrangement to the former; only that the cold atmosphere round the japanned pail had no exterior cold mixture to defend it; which, however, was the less necessary, as the earthen pan was of considerable thickness, and had acquired the temperature of the mixture that had been employed in cooling the 5-lib. of muriat of lime.

In experiments of the kind I have described, all the exterior vessels should be of earthen-ware or wood, which being bad conductors of heat, prevent the ingredients from receiving heat from the atmosphere and surrounding objects with the same facility that they would through metals; and, for a similar reason, the interior vessels are best of metal*, that they may allow the heat to pass more readily from the substance to be cooled into the frigorific mixture employed for that purpose.

Muriat of lime is certainly the most powerful, and at the same time the most economical substance that can be employed for producing artificial cold; for its first cost is a mere trifle, being a residuum from many chemical processes, as the distillation of pure ammonia, &c. and often thrown away: besides, it may be repeatedly used for similar experiments, nothing being necessary for this purpose but filtration and evaporation to bring it to its first state. The eva-

* When we used a glass-retort to contain the mercury, it was that we might be able to see such phenomena as might present themselves during its congelation.

poration should be carried on till the solution becomes as thick as a strong syrup, and upon cooling the whole will become crystallised: it must then be powdered, put up in dry bottles, well corked, and covered with bladder or cement, to prevent liquefaction; which otherwise would soon take place, owing to the great affinity the muriat has for moisture.

The powerful effects produced by the frigorific mixture of muriat of lime and snow presents a wide field for experiments to determine the possibility of fixing some of the gases by intense cold. As soon as an opportunity offers, we mean to attempt some experiments with that view, of the success of which the earliest account shall be sent to the Philosophical Magazine, for the information of those who are fond of such pursuits.

XIV. *Letters from some of the Men of Science engaged in the French Expedition to Egypt.*

[Continued from Vol. II. page 417.]

LETTER III.

Cairo, Thermidor 26th.

I CONFORM to the manners of the Turks. We all wear whiskers, because a bare chin is a sign of slavery; and, though we are here masters, the force of prejudice makes the Turks believe that those Frenchmen who appear without whiskers are the slaves of the rest.

I have just come from the Institute of Cairo. Two palaces of the beys, and two other houses, which belonged to rich individuals, all contiguous, serve to lodge the men of letters and artists. These houses afford us, perhaps, more convenience than is found at the Louvre, and, at least, as much magnificence. An immense garden, the superficial content of which is equal to thirty-five French acres, well planted, and having a number of raised terraces, which the

waters of the Nile, during the time of its inundation, never reach, is destined for botany and the cultivation of plants.

The hall where the Institute meets is already decorated with the richest French furniture found in the houses of the Mamalouks. Besides other articles, there are, a very large fine clock by Berthout, and a Japan vase of great size.

I am just now employed in collecting all the curious animals, which I was told were to be found at the houses of the Mamalouks. Our place for keeping birds is already completed; and in a little time we shall be better established than if we were in the *Jardin des Plantes*. But the greatest ambition of the members of the Institute is to transmit to you the first volume of our memoirs, before those of the French Institute shall appear. We are labouring for this purpose with great assiduity. You will find two memoirs of mine, which I hope will meet with your approbation.

I wish to give you some details, particularly in regard to what I have observed in this country; but too many events have taken place, and I see so many things highly interesting to the philosopher that I really am at a loss what to say or where to begin. I shall, therefore, give you an account only of a breakfast and dinner in which I participated, as they will serve to convey some idea of the manners of the Egyptians.

General Menou, being provisional commandant of the province of Rosetta, was desirous of making a tour through it; and as there are no inns here, and as he was informed, besides, that it is customary for the commandant to accept a dinner from the chief of the canton, the general conformed to that usage. We accompanied him, to the number of fifteen, and had a guard of twenty foldiers. Ninety-six dishes, all touching each other, and disposed in the form of an ellipse, were served up, on the ground, which was covered, however, with mats and carpets. We were treated in a high style. The entertainment did not consist of several services, but, what amounts to the same thing, of several

stories. The largest articles were in dishes of a proportionate size. All these dishes occupied the lower part: they were of a circular form and made of tin, as in France. Three dishes, placed quite close to each other, left an empty space in the middle, which was entirely concealed by a smaller dish. These dishes contained the dainties, which are made by the real Egyptian women. The company first attacked these in order to get rid of them, and that they might have access to the lower range. These dainties consisted of seven or eight kinds of cheese, molasses baked with flour paste, fricasses of rice and mutton baked with raisins, prunes, figs, grenadilloes, &c.

The solid dishes were fowls dressed with rice, or prepared other ways, &c. The ellipsis forming the whole of the service was bordered with half a cubical foot of bread of twelve kinds and different forms: there were cakes of various sorts, elliptic and circular bread, &c. &c.

The Cheik invited us all to squat down around, and we soon saw the Turks in the company put their hands into the dishes, take the liquids in their palms and the solids in their fingers, and in that manner convey them to their mouth. We were obliged to do the same; for we had neither spoons nor forks.

The dinner, which we partook of in a neighbouring village, was not much different from our breakfast, except by the absence of milk dishes, and a less variety in the kinds of bread. The new dishes were, a whole sheep in the middle, and various other viands around, either roasted or fried in a very whimsical manner. The principal domestic, who waited on us, crossed the service through a passage which he made by taking away some of the dishes. When he cut up the sheep, he divided it into pieces by means of his hands and a knife, or broke and tore it without much ceremony, and distributed a part to each.

The Cheik who entertained us at breakfast had a son 34 years of age, a rich farmer, and, next to his father, the most

confi-

considerable man in the village. We wished this young man's son to breakfast with us, and we desired him to place himself at table; but he blushed as if we had asked him to commit a crime. His father told us that his child would never be prevailed on to sit down where his grandfather sat, and above all to eat in his presence: that the profound respect he entertained for his grandfather, made him impose this on himself as a law. We then invited the son to sit down; but he made the same observations in regard to himself, and with a religious solemnity which surprised us. General Menou requested the grandfather to order his children and grand-children to partake in the entertainment; and after some hesitation he agreed, saying, that it was contrary to custom, but that it gave pleasure to his paternal heart. The children obeyed; but they had an air of reserve and timidity during the whole time they were eating. They made haste to finish their meal, and retired speedily according to the custom of the country, which requires those who have no appetite to depart.

After General Menou and his company had finished their repast, the soldiers came, in their turn, to feed upon what we had left. The first, and this second company, who consisted of jolly fellows of a keen appetite, ate at most two thirds of what had been served up, after which the poor of the village were invited. These regaled themselves with what remained. They entirely emptied the dishes, for which they contended, and which they tore from each other in a manner that afforded us much amusement.

These Cheiks behaved with so much liberality only because they are authorised by the laws of the country, when a commander in chief takes a repast with them, to reimburse themselves for the expence they have been at, by an impost which they levy immediately; and as it is therefore the village which treats, the inhabitants have a right to partake in the feast, and to eat up what remains on the table of their lord. But those who actually pay do not participate in the

entertainment: the poor in all countries escape such assessments, and people who are in easy circumstances disdain to go and eat fragments.

Upon the whole, the Egyptians in the country are exceedingly miserable: so much so indeed that the imagination can hardly conceive it. Would you believe that the greater part of the villages consist almost entirely of earthen huts, which are not three feet in height; that the aperture through which these miserable creatures enter their kennels is a circular hole of a foot and a half diameter, and that this hole remains always open; that there is no room in these huts, but what is necessary for the husband, wife and children, all huddled together, to sleep upon; and that, to enter these wretched habitations, they are obliged to creep on all fours? A place built up of earth, on which they bake their bread, occupies the third of the hut; two stones to grind corn, a coffee-pot to make coffee, and a bag containing tobacco, are all the furniture of these poor peasants. They never eat flesh, but they all drink coffee in the morning. The Turks cannot live without coffee and tobacco. Besides these, they seem to be acquainted with no wants. They drink their coffee without sugar, and with the grounds: the more abundant the latter are, so much the more agreeable it is to their taste.

LETTER IV.

Cairo, Fructidor II.

THE members of the National Institute have founded here an establishment like that of Paris. They have associated with them some of the men of letters and artists who followed the army, and some military men have been admitted members also. Generals Kleber, D'Essaix, Regnier, Andreossi and Cafarelli; Salkowski aid-de-camp to the commander in chief, and Sucy chief commissary, have been likewise admitted. This establishment has a very beautiful situation, and in a little time we shall have a botanical garden. A menagerie has already been begun to be formed,

and

and there will soon be a public library, an observatory, a cabinet of philosophical instruments, a chemical laboratory, a hall of antiques, &c. Citizen Monge has been elected president; the Commander in chief, vice-president; and Cit. Fornier, secretary.

XV. *On the new Insect so prejudicial to Apple Trees; and a Method for extirpating them.*

WITHIN these few years an insect, before unknown in this country, has made its appearance in the British orchards, which, if means are not generally taken to root it out, will in a short period destroy every apple tree in the kingdom. It exhibits upon the trees the appearance of a white efflorescence, like what may be sometimes seen on stones in the fields: this seems, however, to be only the habitation of the insects, which exist in millions wherever they have once lodged themselves. On bruizing the efflorescence-like matter between the fingers, a deep red-coloured fluid like blood is expressed, and which probably is of that nature. Already have several valuable orchards been much injured by this insect, which corrodes the apple trees in such a manner as at last completely to destroy their organization and to kill them, without the proprietors, many of them at least, even once suspecting the cause. We hope what we now state will be the mean of making the fact generally known, and of inducing every person interested to co-operate in rooting them out.

We are happy in having it in our power to give them the recipe of a cheap composition discovered by William Forsyth, Esq. his majesty's gardener at Kensington, which has been found effectually to answer the purpose. It is as follows:

Rx. To 100 gallons of human urine add as much cow dung as will bring the whole to the consistence of paint, with which anoint the infected trees about the end of March.

XVI. *Second Communication from Dr. THORNTON, Physician to the General Dispensary, relative to different Trials made with the Factitious Airs.*

SIR,

Feb. 20. Duke-street, Grosvenor Square.

I AM happy to inform you that I have been honoured from the most respectable quarters with several communications for your Magazine, relative to Pneumatic Medicine. Permit me to mention, that the only inducement I have for publishing in your work, is the great estimation I hold it in, the good of my fellow creatures, and a wish to fill up the chasm from the last publications by Dr. Beddoes on the Factitious Airs, until the establishment of a Pneumatic Hospital, the foundation of which is begun to be laid by that enlightened and patriotic physician, when the subject, he says, will be again revived by him. I am, sir,

*To the Editor of the
Philosophical Magazine.* }

Your obedient servant,
ROBERT JOHN THORNTON.

A REMARKABLE CASE OF SCROPHULA CURED BY
VITAL AIR.

Miss Holmer, at 18, an amiable and accomplished young lady, the daughter of a wholesale ironmonger in the Borough*, so early as at the age of seven had the glands of the neck beginning to take on disease. First one gland under the ear, then another, and by degrees all the glands about the neck became enlarged, and went on gradually increasing. The same disposition also shewed itself by an affection of the eyes, for which this lady was nine months under the care of Mr. Ware. During the progress of glandular affection, she was under Messrs. Kent, Fearon, Bayley,

*This lady had all the benefit of country air; her father having a house at Vauxhall, and keeping his carriage, she had every advantage that fortune could give her. EDIT.

&c. &c. and Dr. Saunders. Mercury was used externally and internally until the teeth became loosened, bark, and steel, and soda, or fossil alkali, given in profusion; but each practitioner in turn relinquished the case, recommending sea air, which was had recourse to at sundry times. This young lady was latterly referred to John Hunter, who employed hemlock to an uncommon extent; and he also, as the sea air had been before tried without advantage, advised the parents to do nothing farther, saying, with his usual bluntness, that it was a case of that nature that whoever would undertake the cure would do it only with the intent of picking their pockets. When I first saw the young lady, I observed the glands of the throat, even from the nape of the neck, so enlarged as to defeat all concealment, and forming one apparently homogeneous mass, extended even over the jaw-bones, which could not be felt, and suffocation was threatened by pressure on the wind-pipe. Her relations ridiculed the idea of any farther application for this disease: but parental fondness urged an enquiry relative to the airs. The Rev. Mr. Townsend, rector of Pewsey, author of a very excellent work on physic, the *Guide to Health*, happened to be at my house when the lady arrived. Although he conceived highly of pneumatic medicine, as may be seen throughout this work, he told me, that he must consider me as very bold if I could venture to undertake such a case, which he acknowledged to exceed any thing he had ever before seen; and Mr. Jones, an eminent apothecary in Mount-street, declared, that if I produced a cure here, all he could say was “that *miracles* had not ceased.” I, however, was not discouraged, and the event has proved that we should not, having such new and powerful agents as the airs, readily give way to despair.

In a month after commencing the inhalation of vital air (six quarts daily mixed with thirty of atmospheric), the knot of glands began to soften, yielding a little to external pressure; by degrees they separated from each other, and thir-

teen glands could be distinctly made out; the jaw-bones became liberated; and these, whether from pressure of the glands, or imperfect ossification, were bent up a little from their natural course; and, not to tire the reader, I shall finally remark, that in less than eight months the decrease was *five inches by measurement round the neck!* The hands, which before were unusually cold, were comfortably warm during the whole time the vital air was inhaled, and the appetite and spirits increased. Mr. Cruickshank observed, that during the time of inhaling the superoxygenated air, the pulse were raised about six beats in a minute, and became stronger. I must beg leave to mention here, that I also roused the absorbents by both topical as well as internal remedies. But why I place such a stress on the power of the vital air over this system of vessels, is, that from the experiment of Dr. Beddoes, which he made upon himself, while inhaling a superoxygenated air, he became, he observes, considerably diminished in bulk, although he eat twice as much as before, which I conceive could only arise from the superior energy given to the absorbents by the vital air:—But, however the wise ones, past the age of forty, may smile at *theory*, the *fact* or cure must remain undoubted, and it is intended to lay others (many of which are no less remarkable) in quick succession before the impartial tribunal of the philosophic world.

XVII. *Biographical Memoirs of JAMES BERNOULLI. From the New Transactions of the Imperial Academy of Sciences at Petersburg.*

JAMES BERNOULLI, licentiate of law, member of the Physical Society of Basle, and correspondent of the Royal Academy of Sciences at Turin, son of John Bernoulli, L.L.D., Professor of Mathematics in the university of Basle, and of Susannah Koenig, was born in that city on the 17th of
October

October 1759. Descended of a family rendered illustrious by three geometricians of the first class, and four other mathematicians of great reputation *, he distinguished himself early by his talents and genius, improved by uncommon assiduity and great application to study. Having finished his course of humanity, he was sent to Neufchatel to learn the French language, as is customary at Basle; and on his return, being admitted to the degree of master of arts, he entered his name as a student in law, and attended the lectures of the professors of law in that university with such success, that, in 1778, he found himself in a condition to

* 1. James Bernoulli, professor of mathematics at Basle, member of the academies of Paris and Berlin, born at Basle the 27th of December 1654, died there August 16, 1705.

2. John Bernoulli, brother of the preceding, professor of mathematics at Groningen, and afterwards at Basle, member of the academies of Petersburg, Paris and Berlin, of the Royal Society of London, of the Institute of Bologna, &c. born at Basle, July 27, 1667; died there Jan. 1, 1748.

3. Nicholas Bernoulli, nephew of the two preceding, professor of mathematics at Padua, afterwards professor of logic and then of law at Basle, member of the Academy of Sciences and Belles Lettres at Berlin, member of the Royal Society of London and the Institute of Bologna; born at Basle, October 10, 1687; died there November 29, 1759.

4. Nicholas Bernoulli, son of No. 2, licentiate of law, professor of law at Berne, and afterwards professor of mathematics at Petersburg, member of the Institute of Bologna; born at Basle, January 17, 1695; died at Petersburg, July 26, 1726.

5. Daniel Bernoulli, brother of the preceding, M.D. professor of mathematics at Petersburg, afterwards professor of anatomy and botany at Basle, and then professor of natural philosophy in the same, member of the Academy of Petersburg, Paris and Berlin, and of the Royal Society of London; born at Groeningen, January 29, 1700; died at Basle, March 17, 1782.

6. John Bernoulli, brother of the two preceding, L.L.D. professor of eloquence, and afterwards of mathematics at Basle, member of the Acad. of Paris and Berlin; born at Basle, May 18, 1710; died there, July 17, 1790.

support public theses on some very difficult points of law, and to receive his licence.

In 1780 he made a tour through several cantons of Swisserland in company with a few friends. The account of this short excursion, written in a plain manner, and without the name of the author, may be found in the third volume of the collection of travels published at Berlin by M. John Bernoulli.

The study of the law, and the application he gave to that branch of knowledge, was not able to extinguish his geometric spirit hereditary in the family. The lessons which had been given him by his father in his youth, and which were afterwards continued by his uncle, the celebrated Daniel Bernoulli, had increased his innate and irresistible propensity to the mathematical sciences. His rapid progress inspired him with the most flattering hopes, and induced the heads of the university to entrust him, in 1780, with the functions of his uncle, whose age and infirmities had rendered him incapable, for some time, of continuing his lectures on experimental philosophy. Mr. Bernoulli discharged these functions, till the death of his uncle, to the satisfaction of his auditors and the university; but he had not the pleasure of succeeding to the vacant chair, though his name was inserted in the list of candidates, because academic places at Basle are determined by lot, as well as all the other offices of the republic; and, on this occasion, the lot was unfavourable to him, a caprice of fortune which he had experienced in 1780, when he stood candidate for the chair of eloquence, at that time vacant. It was on this last occasion that he published his *Theses on the Sublime*. This double disappointment, joined to a strong desire of seeing the world, so natural and so powerful in young men, made him soon after form a resolution, agreeable to his prevailing taste for travelling, but which seemed likely, for a little time, to lead him aside from the literary career he had entered with so much applause; and he ac-

cepted the place of Secretary to Count de Breuner, minister of the Imperial Court of Vienna to the Republic of Venice.

This office furnished him, indeed, with the wished-for opportunity of travelling, and of seeing successively a great part of Germany and Italy; but he could not travel always, and when he arrived at the place of his destination he became tired of a manner of life so little conformable to his way of thinking, and unfavourable to his taste for study. The society of a small number of literary men, and particularly of some geometricians of reputation, with whom he formed an acquaintance in Italy, and who received him in a manner suited to the name he bore, and to his personal merit, rendered his situation comfortable for some time. The friendship of these distinguished characters, among whom was the celebrated Lorgna, gave an agreeableness to his residence in that country, of which he long preserved a remembrance; but it could not extinguish the desire of soon finding a place where he might devote himself entirely to the mathematical sciences, and make use of the knowledge he had acquired in them, and of which he had given public proofs in the Memoirs of the Royal Academy of Sciences and Belles Lettres at Berlin, and in those of the Royal Society of Turin, who received him among the number of their corresponding members, during his residence in the latter city.

The disposition of mind above mentioned having, by means of John Bernoulli at Berlin, come to the knowledge of his countryman Mr. Fufs, the latter embraced a favourable opportunity of mentioning him to the princess of Daschkaw; and her excellency being already disposed to repair the loss which the Academy of Petersburg had sustained by the death of Mr. Lexell, found that Mr. Bernoulli, independently of his personal merit, had a distinguished right to aspire at a place in an academy to which, since its foundation, his grandfather and two grand uncles had rendered essential services. Bernoulli, therefore, received

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the vocation of an adjunct, with a salary of 600 rubles, and the promise of being promoted in the course of a year. He accepted these offers with joy, and quitted Venice in the month of May 1786, taking the route of Swisserland to revisit his country and family before he went to Russia, where he was to establish himself, in consequence of his engagement, for at least three years.

Scarcely had he reached Petersburg when his ruling passion for travelling, or, what amounts to the same thing, his desire of acquiring knowledge, made him conceive the idea of participating in a sea voyage planned at that time, and for the execution of which several vessels, destined to sail under the command of M. Moulouski, were then fitting out. Mr. Bernoulli ardently wished to have a share in this expedition as astronomer, and conversed on that subject with the chief of the expedition, who received the proposal with pleasure, and promised to get the conditions they had agreed on sanctioned; but Mr. Bernoulli's friends induced him, though with great difficulty, to renounce a voyage the fatigues of which his weak and delicate constitution could not have supported.

Having abandoned this plan, which had given him much pain and uneasiness, he applied himself with the whole activity of his soul to physical mathematics. He laboured with great diligence, and surpassed so much the hopes conceived of him by the academy, that, before the expiration of the time fixed in his agreement, he found himself honoured with the title of ordinary academician. In the short space of little more than two years, he presented and read eight memoirs, inserted in the six first volumes of the *Nova Acta Academiæ Scientiarum Imperialis Petropolitaneæ*, which display great penetration, a precise and acute mind, a solid judgment, and much more address in the management of analytical formulæ than could have been expected from a geometer so young; according to appearance, in the secret of analysis and the resources of calculation.

In 1788 his excellency Count d'Anhalt appointed Mr. Bernoulli one of the professors who instruct the Imperial corps of noble land cadets, charging him to teach algebra to the two first classes. In this office he distinguished himself by much zeal and attachment to the duties it imposed. He engaged, among other things, to make for the use of that corps an extract from Mr. Euler's Algebra; but death prevented him from commencing that work.

In 1789 Mr. Bernoulli married the youngest daughter of Mr. John Albert Euler. This marriage, which promised to the young couple durable felicity, and which united two names equally dear to the sciences, and respectable in the republic of letters, was dissolved, two months after it was solemnised, by the tragical death of the husband, who was carried off by a stroke of the apoplexy on the 3d of July the same year. A residence in the country, and the convenience of bathing every day in the Neva, had made him resume a taste for that practice and the exercise of swimming, which is so salutary, but so often fatal. He was well accustomed to the art, and consequently had no fear of any unlucky accident; but whether he had neglected to dip his head first, or had bathed too soon after dinner, during the operation of digestion, which to him was difficult, or whether the germ of the malady had been already in his constitution, he suddenly became insensible and motionless; and though he was almost immediately drawn out by his brother-in-law, and though all the usual methods were tried, assistance was useless, and the physicians unanimously declared that he had been struck with a stroke of the apoplexy. It has been already observed, that Mr. Bernoulli was of a weak and delicate constitution. In the autumn of the year 1787 he was attacked by a nervous fever, which exposed his life to great danger. He, however, recovered; and it is to be presumed that his constitution would have been established, and that it would have been able to resist the severity of the climate of Russia, if Providence had not disposed

VOL. III. H

posed otherwise, by snatching him from the sciences and the academy in the 29th year of his age.

To an open, free, and tractable disposition, Mr. Bernoulli joined much modesty and mildness—qualities which procured him the friendship and esteem of all those with whom he was acquainted, and which justified, as much as his learning, the deep regret occasioned by his premature death. The following is a list of his writings :

Dissertatio Inauguralis Juridica. Basiliæ, 1778.

Theses Juridicæ. Ibid. 1779.

Theses de Sublimi. Ibid. 1780.

Description of a Tour through Swisserland, in the month of August 1780. (In John Bernoulli's Collection of Short Tours, Vol. III.)

Lettre sur l'Elasticité. (In the Journal de Physique de l'Abbé Rozier, Suppl.)

Memoire sur la Theorie d'un Instrument qu'on pourroit nommer Machine Balistique. (Mem. de l'Acad. Royale des Sciences et Belles-Lettres de Berlin, ann. 1781.)

Thoughts on the Question, Why in our Disappointments we find Consolation in the Misfortune of Others? (*Nutz Beytrage zu den Neuen Strelitzischen Anzeigen.* Jan. 1782.)

Theses Physicæ. Basl. 1782.

Essai d'une Nouvelle Maniere d'Envisager les Differences, ou les Fluxions des Quantites Variables. (Mem. des Corresp. de l'Acad. Royale de Turin, ann. 1784 and 1785, Tom. I. p. 2.)

Observations made in a Tour from Vienna through Styermarek, the Ukrain and Friaul, 1785. (In John Bernoulli's Collection of Short Tours, Vol. XVI.)

Considerations Hydrostatiques. (Nova Acta Helvetica, Tom. I.)

Analytical Solutions respecting a Parachute attached to a Balloon. (*Leipz. Magaz. fur Reine u. Angew Math.* Part I. 1786.)

Sur le Mouvement Gyratoire d'un Corps attaché à un Fil extensible. Premiere Memoire. (Nova Acta Acad. Sc. Imp. Petrop. Tom. I. pro anno 1783.)

Sur le Mouvement Gyratoire, &c. Second Memoire. (Nova Acta, Tom. II. 1784.)

Sur le Mouvement Gyratoire, &c. Troisieme Memoire. (Nova Acta, Tom. III. 1785.)

Dilucidationes in Commentarium III. Euleri de Ictu Glandium contra Tabulam Explosarum. (Nova Acta, Tom. IV. 1786.)

Essai sur une nouvelle Machine Hydraulique propre à élever de l'Eau. (Ibid.)

Essai Theorique sur les Vibrations des Plaques élastiques Rectangulaires et Libres. (Nova Acta, Tom. V. 1787.)

De Motu progressivo, rotatorio et oscillatorio duorum Corporum Ope Fili super Trochleam transeuntis connexorum. (Nova Acta, Tom. VI. 1788.)

De Motu et Reactione Aquæ per Tubos mobiles transfluentis. (Ibid.)

Mr. Bernoulli translated also Merian's Philosophical Memoirs (*Memoires de Philosophie de M. Merian*) into German. 2 vols.

NEW PUBLICATIONS.

Nova Acta Acad. Scient. Imper. Petropolitanæ, &c. New Transactions of the Imperial Academy of Sciences at Petersburg. Vol. X. 1797. With 13 Plates,

OF the mathematical papers in this volume, most of which are by Leonard Euler, it is impossible to give any satisfactory account in the limits allotted for this present article. Among the astronomical papers are:—On the Perturbation of the Motion of Saturn, by Schubert. The author has

employed, but with some variation, the formula of De la Place in regard to the theory of Jupiter and Saturn. On the Variation of the Obliquity of the Ecliptic, and of the Tropical Year, by the same. Observations made in the Observatory of the Academic College at Mientau, from 1791 to 1795, by M. Beitler. Observations made in 1795 at his own house, by M. Inochodzow. Observations on a Solar Eclipse, by M. Kumowski. Extracts from Meteorological Observations made in 1768 and 1769, at Jakutsk, by J. Islenief. The greatest height of the barometer was 28.07 Paris inches, the least 26.17. On the 11th of December 1768, at 4 in the afternoon, the mercury of a De Lisle's thermometer, the scale of which reached only to 228° below boiling water*, sunk entirely into the bulb. About 8 o'clock on the 12th, the observer exposed to the open air another thermometer, the divisions of which reached down to 245°; and at 8 o'clock in the morning of the 15th, the quicksilver stood at 229° (62.8° Fahr. below 0°). Having moved the instrument, the quicksilver fell suddenly into the bulb, and remained in it till 8 o'clock in the morning of the 19th; but at noon it rose to 199° (26.8° of Fahr. below 0°). Extracts from Meteorological Observations made at Peterburgh in 1792. In the department of Physics we find C. F. Wolff's Tenth Dissertation, fourth part, on the Muscular Vessels of the Heart, illustrated with engravings. Method of purifying Corrupted Water, with new Experiments, by Lowitz. A little sulphuric acid and common salt, when the water is intended for the purposes of cookery, strengthens the effect of the charcoal powder. The same author gives an account of his having discovered Strontian earth in sulphat of barytes, in which, according to his numerous experiments, it forms a fifth part, and is always present. He explains the difference between it and cal-

* The scale of De Lisle's thermometer commences with the point of boiling water. The freezing point is 150° below boiling. EDIT.

careous earth and barytes chiefly by its union with acids, and gives directions for preparing the muriat of barytes for medical purposes. Three papers by B. Sewergin, on different species of talc, the Russian kinds of serpentine, and the cyanite. A Physical and Topographical Sketch of Tauria, by Professor Pallas; also a Description of some new Siberian Plants (with figures) from the Collection of the late J. Sievers of Hanover, viz. two species of robinia, the *pubata* and *tragacanthoides*; a species of sophora, *argentea*; tamarisks, *songarica*; roses, *berberifolia*; molucella, *diacanthophylla*; rhubarb, *leucorbizon*; and three kinds of ribes, *saxatilis*, *fragrans* and *tristis*. Herrman's Mineralogical Observations made during a Journey through the Chain of the Ural Mountains, which he traversed from West to East. J. T. Kölreuter on the true Organs of Fructification in the *Periploca Græca*. Professor Lepechin's Description of a new Siberian kind of *Polygonum*, which he calls *Laxman*, from the discoverer, and of which a figure is given. It has a large stem, and its flowers are furnished with eight stamina and three styles, placed in tender panicles at the angles of the leaves, which are lanceolated, of equal breadth, smooth, and sharp pointed.

Reise durch Pommern nach der Insel Rügen, &c. A Tour through Pomerania to the Isle of Rugen and a Part of the Duchy of Mecklenburg, in the Year 1795. In a Series of Letters, by John Frederic Zöllner. With Copper Plates. Berlin 1797, 8vo.

THE route which the author pursued, in this tour, was through Stettin, Wollin, Swinemünde, Wolgast, Greifswald, Stralsund, Hiddensä, Barth, Rostock, Dobran, Remplin, Strelitz, Ruppın, and thence to Berlin. The work, besides a descriptive account of the places which the author visited, contains also anecdotes of remarkable persons, and observations respecting trade, manufactures and natural history. In an Appendix is given a great many statistic observations

relating to Pomerania, Rugen, Mecklenburg, &c. Tables of the exports and imports of Stettin in the year 1794; of the number (535) and value of the ships built in Swedish Pomerania, between the years 1781 and 1795; and of the heights of the barometer on the 6th of August 1795, observed at Petersburg, Berlin, Halle, Breslau, Rudolstadt, Bayreuth, Seburg, the Brocken, St. Gothard, two eminences in Rugen, and at other places.

Voyage Pittoresque de la Syrie, &c. Picturesque Travels through Syria, Phenecia, Palestine and Lower Egypt. No. I. and II. Paris, 1798.

THIS work consists of elegant engravings accompanied with proper descriptions. The plates in the first number are: 1. A view of the cenotaph of Caius Cæsar near Hems, formerly Edeffa. 2. View of a part of the village of Cana in Galilee. 3. General view of Jerusalem. 4 and 5. Sepulchral monument of the cities of Judah. 6. Fortune-tellers. Those of the second number are: 1. Gate of the Temple of the Sun at Palmyra. 2 and 3. Portico of Diocletian. 4. Beautiful view near Tripoli. 5. Entablature of the Temple of the Sun at Balbec. 6. Course of the Nahr Quades or Sacred River.

The whole work will be comprised in three volumes folio, containing about 300 engravings besides vignettes, and will make 50 or 55 numbers. The price of each number, to subscribers, is 30 livres (25 shillings); to non-subscribers 35 livres (about 29 shillings).

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

FRANCE.

SOCIETY OF HEALTH IN THE COMMUNE OF NANCY.

THE public fitting of this society on the 1st of Frimaire, VII. Year, was opened by C. Lallemand, president, who read a discourse on the utility of medical correspondence for preserving purity of principles in the art of healing, and on the most advantageous method of teaching it.

C. Mandel, professor of therapeutics and pharmacy, read a dissertation on iron. The author explained the different states in which it is found naturally; those which may be given to it by art; and the services which it has rendered to mankind by its magnetic properties, particularly in regard to the mariner's compass, and its power of attracting lightning and conducting it to any place required. He demonstrated the affinity of this metal with oxygen, the cause of its so easily uniting with saline substances, and of its speedy oxydation by air and water, and of its solution in the latter vehicle which it decomposes. He then proceeded to the action of iron on the animal economy, and took a view of the speedy cures which it effects; and the accidents, on the other hand, which it has occasioned to some individuals, even when the dose was weak. This led him to propose the following very interesting question, Whether the iron which exists materially and formally in our humours, and above all in the blood, might not be considered, on account of its natural

increase and diminution, as the cause of a great number of diseases? And he mentioned chlorosis as one of those most likely to conduct to a satisfactory result.

He mentioned the new system (quoting Dr. Rollo), which holds that the greater or less quantity of oxygen in the blood is the cause of various diseases. Without denying this principle, he combated the application made of it by Dr. Rollo to certain diseases, particularly chlorosis, which he imputes to a privation of oxygen; to restore which, he recommends metallic oxyds as being proper to furnish oxygen. C. Mandel asserts that this disease is destroyed by medicines capable of carrying off oxygen, instead of introducing it into the system: that it is cured by iron which has undergone no other preparation than a great division of its parts; from which he concludes, that not disoxygenation, but rather *deferrugination*, ought to be assigned as the determining cause.

The author next pointed out the different medical cases in which iron, or preparations of it, ought to be administered; and then examined the question whether the magnet ought to be admitted among the means of medical cure, or entirely rejected. He gave an account of the different systems of the partisans and antagonists of this mineral: he combated from experience the opinion of the latter, and shewed that there was nothing less doubtful than that the iron contained in the blood, though in a state of oxyd, cannot be attracted by the loadstone. In the last place, he concluded, without admitting all the wonders ascribed to it, that this mineral ought to be retained among the curative means.

C. Salmon, professor of the materia medica, communicated two observations which tended to support the last assertion.

C. Willemet, professor of botany, read some fragments in regard to the natural and literary history of several kinds of laurel—a plant held in great veneration by the ancients. This valuable tree was employed in all their religious ceremonies,

monies, had a share in their mysteries, and was made the reward of valour, merit and virtue. Its medical properties were not forgotten. In speaking of the laurel-cherry, (*prunus lauro-cerasus*, L.) C. Willemet gave an account of the modern experiments made on the effects of the water distilled from it. He took a view also of the qualities and virtues of the common rose-bay or oleander (*nerium oleander*, L.); the — (*ruscus hypoglossum*, L.); and the laurestine (*viburnum tinus*, L.)

ITALY.

The National Institute of the Ligurian Republic was installed on the 24th of Brumaire, 7th year, by the directory of that republic. It consists of sixty members, thirty-six of whom are resident; and thirty-six associates, inhabitants of the republic. They form two classes, each of which is subdivided into three sections.

The first class is that of the Mathematical and Physical Sciences; the three sections of which are: 1st, Agriculture, commerce and manufactures; 2d, The nautical science, mathematics, physics and natural history; 3d, Chemistry, botany, anatomy, medicine and surgery.

The second class comprehends Philosophy, Literature, and the Fine Arts. Its sections are as follows: 1st, The art of reasoning; and analysis of the operations of the human understanding, grammar, eloquence and poetry; 2d, Political sciences, history and antiquities; 3d, The art of design.

ROYAL SOCIETY OF LONDON.

Since our last report, (Vol. II. p. 327) Papers on the following subjects have been read to the Society.

One on the methods of finding the latitude by double observations, which contained several curious calculations and useful tables. This paper, which occupied almost the whole of two evenings, is of such a nature that our limits will not allow our giving any account of it.

A paper containing meteorological observations made at Constantinople, and some curious information respecting the plague which so often causes dreadful devastation in the Eastern countries. The remarks brought forward on this subject go to establish the fact, that the infection is only caught by contact either of a diseased person, or of articles that have been in contact with the infected.

A paper on the natural history of the elephant, by John Corse, Esq. author of the article on the same subject given in a preceding part of the present number of our work. This paper, which contains a great variety of curious information, excited much attention. His observations are the result of many years residence in India. By them it appears that the accounts of the sagacity, modesty and size of the elephant have been greatly exaggerated by natural historians. The female, when brought forth, is about 35 inches high; when full grown, from 7 to 8 feet. A full grown male is 8 or 9 feet high, measured at the shoulder as the height of a horse is taken.

A paper on the decomposition of the boracic acid, by M. Crell.

ANTIQUARIAN SOCIETY OF LONDON.

On Thursday the 14th of February, an Eolopile of great antiquity, made of brass, and which had been dug up in making the Basingstock canal, was presented to this Society by Mr. Fry the letter-founder. The form is singular: instead of being globular with a bent tube, it is in the form of a grotesque human figure. The blast comes from its mouth. The only thing similar we have ever met with in this country is the eolopile called Jack of Hilton, mentioned in Plott's History of Staffordshire.

MISCELLANEOUS.

ANTIQUITIES.

MEN of letters, artists, and those fond of antiquities and numismatics, had long regretted, that the rich collections of medals and gems in possession of the royal family of Prussia were scattered and preserved in different places. The late king, who approved of a plan presented to him for uniting all these collections in the capital, caused to be brought thither, towards the close of his reign, and deposited in his own cabinet, the beautiful collection of ancient and modern medals, crown-pieces, &c. which the margraves had formed at Anspach, and to which he made considerable additions. To complete the execution of the above plan, it however still remained to add to the cabinet of Berlin the grand collection of ancient medals and gems preserved at Potsdam. This valuable collection, made by Frederick I. and described by that celebrated antiquarian Beger*, was enriched afterwards by Frederick II. who purchased the antique medals of Pfau, and the magnificent cabinet of gems of Baron de Hofch, almost unique of its kind. This collection was brought to the capital in 1770, and placed by Frederick II. in the Temple of Antiques at *Sans Souci*, where it long served for the noble amusement of that great man, who was fond of being surrounded by master-pieces of every art, and by every source of instruction. His present majesty has lately gratified the wishes of artists and men of letters, by ordering, on a proposal made to him by the Directory of the Royal Academy

* Laurence Beger, the son of a tanner at Heidelberg, and born in 1653, was librarian to Frederic William, elector of Brandenburg. He was member of the Academy of Berlin, and died there in 1705. He was esteemed by the Learned for his works, among which are: *Thesaurus five Gemmæ, Numismata, &c.* 3 vol. fol. 1696 and 1701; *Regum et Imperatorum Numismata à Rubenio edita* 1700, fol.; *De Nummis Cretenſium Serpentiferis*, 1702. fol. EDIT.

of Sciences, that this collection should be transferred to Berlin, and incorporated with his collection. The directory of the academy, in order to promote farther his majesty's views, and to complete the royal cabinet, have added to it two valuable collections belonging to the academy, viz. that of Lippert's * casts, and that of the bracteals, or coin of the middle ages, formed by Rau, and augmented by Mohsen †; so that the royal cabinet contains at present about 5400 engraved gems, 3000 casts by Lippert, 16000 antique medals, 5000 bracteals, with 5 or 6000 modern medals and crowns. Among the modern series, the richest is that of the medals and crowns of Prussia.

ANATOMY.

C. Cuvier, in the course of his researches respecting the anatomy of white-blooded animals, which he intends soon to publish, has found that the leech will oblige him to change the general denomination. He observed in that animal red blood, not that which it sucks, and which would be contained in the intestinal canal, where it is immediately altered, but a real nourishing fluid contained in the vessels, and circulating there by means of an alternate movement of the systole and the diastole. These vessels form four principal trunks, two of which are lateral, the third dorsal, and the last ventral. The two former are of an order different from that of the two latter; but the author has not yet been able to determine which are the arterial and which the

* Philip Daniel Lippert, professor of antiquities in the Academy of the Fine Arts at Dresden. He was born at Meissen in 1702, and died on the 28th of March 1785. Among his works are *Dactyliotheca*, or, A Collection of the Engraved Stones of the Ancients, consisting of 200 impressions from the principal cabinets in Europe, for the use of the fine arts and artists. Leipzig, 1767. A Supplement to the *Dactyliotheca*, consisting of 1049 impressions. *Ibid.* EDIT.

† John Charles William Mohsen, member of the college of physicians, physician to his Prussian Majesty, and to the school of Noble Cadets at Berlin. EDIT.

venal. The two lateral vessels proceed from one end of the body to the other, and are joined by branches which form a very beautiful tissue when injected. The ventral and dorsal vessels do not form a tissue of the like kind. They only throw out branches disposed alternately in an oblique direction, and subdivided in the usual manner. The second is placed exactly under the medullary cord of the ganglions, from which all the nerves proceed. It is impossible to open a leech without producing a great effusion of that blood. Enough, however, remains in the vessels to be distinguished. Its colour is almost the same as that of the arterial blood of the frog.

NORTHERN GEOGRAPHY AND STATISTICS.

M. Hammer, conductor general of the diocese of Aggerhuus in Norway, who left all his property to the Royal Norwegian Academy of Sciences, endowed also a foundation, which has been confirmed by his Danish Majesty, and in consequence of which a part of the money bequeathed is to be laid out in printing his manuscripts, and for purchasing natural curiosities, the productions of Norway. Another part is to be employed in defraying the expence of travels through Norway, and the following districts are in particular to be explored: Neiden, Powig, Peisen, Nordfieldet, the White Sea, and Dvinaan, the most remarkable natural objects of which must be described. These travels are to be conducted on the plan proposed by Linnæus in the *Norwegian Household Calendar*. All remarkable objects and antiquities are to be illustrated with maps and drawings, and the journals of the different travellers will be inserted among the papers of the society.

Baron Hermelin, counsellor of mines, one of the richest men in Sweden, is now employed in preparing maps of every province of that kingdom, which he means to publish at his own expence. He has already begun with Lapland and the northern districts;

ASTRONOMY.

On the evening of Frimaire 16th, C. Bouvard, astronomer belonging to the Observatory at Paris, discovered a comet in the constellation of Hercules. At half after six next morning, its right ascension was $248\frac{1}{2}$ degrees, and its northern declination $31\frac{1}{2}$. It had advanced 43 minutes per hour towards the east, and 28 towards the south. It was small and difficult to be seen. It forms the 89th, according to the catalogue, in De Lalande's Astronomy.

MANUFACTURES.

Michael Szekely, overseer of mines to Count Schönborn at St. Nicholas, near Munkats in Hungary, has manufactured a kind of cloth from the swallow-wort (*asclepias vincetoxicum*) interwoven with silk. A specimen of this new production, consisting of $6\frac{3}{4}$ German ells, was presented to the magistrates of Ofven for inspection. The first manufacturing of it cost about 7 or 8 shillings sterling, but in future the same quantity will cost only 3 or 4 shillings. It was two ells in breadth, and of considerable fineness.

ARTIFICIAL COLD.

Nearly at the same time that Messrs. Pepys and Allen were engaged in the interesting experiments, of which we have given an account in the preceding pages, Mr. Walker of Oxford was also employed in producing frigorific mixtures. For this purpose, he used the same materials in the following proportions: 4 parts of the crystallised muriat of lime, pulverised, to 3 parts of uncompressed dry snow. On the 4th instant, having, by means of a previous mixture, reduced his materials to 40 below 0° , on mixing the cooled ingredients, they gave a temperature of -63° or 95° below the freezing point of water. We believe the experiment was only on a small scale. We have not learnt what substances, or whether any, were exposed by Mr. Walker to the cold mixture.

MINERALOGY.

A lode* of silver, tolerably rich, has lately been discovered in the Hurland Mine, formerly called the Old Manor Mine, in Gwinear parish in the county of Cornwall, which they are now working, and which, judging from present appearances, we should expect would turn out of great national benefit, if we were not aware of the strong prejudices and great ignorance of the Cornish miners in general.

If we may credit the testimony of foreigners, the poorest mine in Cornwall is worked at a greater expence than the richest on the Continent. How can it be otherwise, while the present system, disgraceful to the age in which we live, is allowed to continue, without any attempts being made either to alter or improve it? We shall hardly be credited when we state that, in many places, the proprietors are never permitted to have a section of their mine: yet such is literally the fact. It would be incroaching upon the province of the *Captain of the Mine*! who is sole monarch of the subterranean legions, and guides all their operations.

From this man the owners must be content to receive the only accounts they can obtain of the state of their works; nor can they possibly help themselves, or interfere in the direction.

When it is known that this is the state of management, our readers, though they may regret the circumstance, will not be surprised to hear that the Wherry-mine near Penzance, one of the most curious in the world†, and in which we lately announced that cobalt had been found, has been discontinued working, and the shaft been closed up. Have we not reason to fear that this mine, so rich in tin and cobalt, has fallen a disgraceful sacrifice to the ignorance in the art of mining, which so shamefully prevails in this county? While science is excluded, what can be expected?

* The Cornish term for a vein or stratum.

† The mouth of the shaft was more than 600 feet from the shore, and surrounded by the sea.

The French Government have lately taken the state of the mines in France into their consideration, established a school of mineralogy under the auspices of the minister of the interior, and are now devising means for propagating instruction relative to that important branch of industry.—The state of the mines in this country calls loudly on our Government to endeavour to devise some mean of improvement. The loss that results to the community from the prevailing ignorance of the operative people employed in them is absolutely incalculable. How happy should we feel, if our well-meant hint should have the effect to make the matter be taken up by those who have influence sufficient to accomplish the object!

DEATH.

On the 26th of November last, of a nervous fever, Frederick Albrecht Charles Gren, Public Professor of Medicine, and Member of the Society of the Searchers into Nature at Halle. He was born on the 1st of May 1760, at Bernburg. His premature death is a great loss to Chemistry and Natural Philosophy. The *Journal der Physik*, or Journal of Natural Philosophy, begun in 1770, of which he was editor, is well known. Among his works are: Observations on Fermentation and the Products thence obtained, 8vo. Systematic Manual of Chemistry, 2 vols. 8vo. Principles of Natural Knowledge, 8vo. *Observationes et Experimenta circa Genesin Aeris fixi et phlogificati*, 8vo. Principles of Pharmacology and the Materia Medica, 2 parts.—He was a contributor also to the *Allgemein-Literatur-Zeitung* of Jena, and author of various papers in Crell's Chemical Annals.

THE
PHILOSOPHICAL MAGAZINE.

MARCH 1799.

- I. *Account of a remarkable Fiery Eruption from the Earth, in Iceland, in the Year 1783. By S. M. HOLM, S.S. Theol. Cand.*

THE following account is taken from a small work written by Mr. Holm, a clergyman, and published in the Danish language at Copenhagen, with two charts. The author says, in his preface, that he was born in the island in the year 1750, and lived there till the year 1774; that he had himself seen all the places mentioned in it, and had since kept up an uninterrupted epistolary correspondence with his countrymen, from whom he received the particulars of the devastation occasioned by this singular disaster.

On the 1st of June 1783, several violent shocks of an earthquake were felt in various parts of Iceland; and these shocks afterwards increased to such a degree, that, on the 11th of the same month, the inhabitants were obliged to desert their habitations and to live in the open air. About the same time smoke and vapour were seen to rise alternately from the earth in the wild districts towards the north, in the neighbourhood of Sidu, Landbrot, Medalland and

Alptaver. After this three columns of fire were observed, the most northern of which first made its appearance. When first seen, they flamed up separately; but they afterwards united and rose to such a height that they could be perceived at the distance of thirty-four miles, when the flame was not covered by thick vapour.

Iceland is bordered by a long chain of mountains, which are all exceedingly high and always covered with snow. The largest and highest of these is the Klofa-Jœkul, in which the principal and best known rivers of the island formerly had their sources. Among these mountains there are also four volcanoes, the Skaptar-Jœkul, the Sula, Trœllyngia, and the Oerœfa-Jœkul, the last of which is the most violent. They at first throw out water, and then fire. There are several of the same kind in the island; but the well known Hecla throws out only fire.

On the 8th of June the bright flames of the before-mentioned column could be clearly distinguished. They were accompanied with a violent and incessant eruption of sand, sulphureous dust, ashes, large pumice stones, and most dreadful explosions. A furious wind, which prevailed at the same time, filled the atmosphere in such a manner with sand and sulphureous vapour, that people could not see either to read or to write even at noon. The ashes and scorixæ which fell back from the atmosphere were red hot. There fell at the same time a kind of filth as black as ink, which seemed as it were hairy, having sometimes the appearance of small balls, and sometimes of wreaths or rings.

On the 11th the fiery column, which had vanished for a little, again made its appearance, and could be distinctly seen at the distance of thirty or forty miles. Its thundering noise could be heard at the same distance, and continued throughout the whole summer. The above column was accompanied the same day by a very violent rain, which occasioned infinite damage; because the water, in many places, swept off whole pieces of the soil and carried them with it
into

into the deep gulphs. The water of this rain was at the same time so sharp and acrid, on account of the many saline and sulphureous particles which it contained, that it occasioned severe pain in the hands and feet where it fell.

The places in the neighbourhood of this column were at the same time exposed to violent cold, snow, and hail of an uncommon magnitude; but, as the column extended farther, these were succeeded by a scorching and almost unsufferable heat, and the sun appeared like a red globe. This heat continued for several days without interruption, and returned several times in succession. All those places to which this destructive column extended were, by the showers of stones and ashes that accompanied it, deprived of all their grass and every other plant; so that the inhabitants were reduced to great distress, and their cattle were frequently killed on the spot. In many places every vegetable production was as it were covered by a hard crust, from the continual sulphureous evaporation.

When this fiery eruption first broke out, the river Skapta was swelled up in an uncommon manner, and a like overflowing was observed in several other rivers. On the 11th of June the Skapta suddenly disappeared, and became totally dry in the course of twenty-four hours. Its bed was situated in a gulley called Skaptar-Gliufur, which extends four miles northwards through the highest rocks, and is above 200 fathoms deep. In this monstrous gulley there arose, the second day after the Skapta was dried up, a dreadful and undescribable fiery lake, which gradually increased till it overflowed the banks and filled all the neighbouring places whether high or low, the most exalted summits only excepted. Having inundated the farm of Buland, it covered not only the adjacent fields and hedges, but also the houses and the church, though the farm is situated on a high rock. Towards the east it extended six miles in breadth; its extent towards the west was also considerable; but towards

the south its progress had been checked by lofty mountains.

Thus swelled and towering up into huge waves it endeavoured on all sides to procure a passage, which, by its continually pressing forwards, it at length effected towards the south in a valley between the mountains. Through this opening it rushed with incredible violence and force, like the most terrible cataract, into the plain on the south, over which it rolled, amidst strong concussions of the earth and awful thunder and explosions in the atmosphere, carrying before it stones, rocks and small eminences. This flaming lake boiled and foamed in a dreadful manner with melted stones, iron, and other substances capable of being liquefied; some of the ignited rocks and stones, as large as whales and houses, were seen swimming on its surface, or driving up and down.

In the mean time smoke and vapour arose from the earth, both in the neighbourhood of this fiery lake and in the more remote districts. All these appearances continued incessantly both day and night from the 12th of June till the 12th of August. The lake still spread itself in the open plains, but with less impetuosity than before. The boiling and foaming, however, continued until it at length began to settle, and to form itself into a solid body. In many places it was found to have been 70, and in others 140 fathoms in depth. When it threw itself with violence into the bed of any river, the water which it displaced overflowed all the adjacent lands, and still added to the devastation and distress it occasioned. Seventeen farms were burnt by the fiery stream, and four swept entirely away by the water, besides a great many others which were destroyed by lightning and the large stones that fell from the atmosphere; so that their inhabitants were reduced to poverty, and obliged to wander about begging for relief. Three large rivers, the before-mentioned Skapta, the Hlversisflot, and the Steinf-

myrarflot,

myrarfliot, besides eight smaller ones, were found entirely dried up.

On the 16th of August the fiery lake began to cease spreading farther. Wherever it proceeded it had burnt and destroyed houses, churches, villages, fields, meadows and forests. Among the places destroyed were many abounding with excellent herbs, such as the *elymus arenarius*, and medicinal plants; the want of which was a great and irreparable loss to the island.

This fiery eruption, however, did not yet cease, but continued to rage with fury till October in the middle parts of the island, where vapour, flames, thunder and concussions of the earth were in succession observed among the cold and extensive mountains. In the first half of November little change had taken place; but the flames began gradually to burn up with more brightness, which was considered as a sign that the inflammable matter was now nearly exhausted, and that the flame would be extinguished; especially as it had before assumed a variety of colours, such as green, blue and the like, according to the difference of the substances by which it had been nourished.

When the eruption first took place, the whole atmosphere of the island was so filled with smoke, vapour and dust, that the sun had entirely a red appearance. In the neighbourhood of the mountains it was perfectly dark at noon; and the cold in the night time, considering the warmth of the season, was very sensible. Where the atmosphere was dry, the fire made the air highly oppressive; but where moist, such severe winter cold was produced in it, that the grass, plants, and cattle were almost destroyed. The cows gave scarcely an eighth part of the usual quantity of milk; and a four-year-old wether, which before would have had ten pounds of fat, had now only two, and was so weak as to be scarcely able to stand.

The ashes, sulphur and rain which fell from the heavens, were so pestilential that they seemed to penetrate the very

bodies of the cattle. Their hoofs became white; their hair fell off; and they were covered all over with pustules and ulcers. The meadows also suffered severely; and the cattle which had endeavoured to pick up the few scanty remains of grafs that had been left, might be seen lying dead on them in heaps. Many others were destroyed by hunger; and it was only a few that were saved by the means of hay. The cattle in general were so stunned, sometimes by the dreadful explosions of the thunder, and the incessant roaring and fire in the atmosphere, that they ran into marshy places, threw themselves over precipices, or even rushed into the flames.

These uncommon phenomena were no less destructive to the inhabitants. Many, in particular old people, and those whose lungs were weak, could with difficulty breathe on account of the sulphureous stench and vapour proceeding from the flames. Many also who enjoyed good health were reduced to a state of illness; and many would have been suffocated had not moderate showers of rain, which fell sometimes, cooled and refreshed the atmosphere.

Besides these circumstances which took place in Iceland, many other phenomena worthy of notice occurred in the neighbourhood. A new island was thrown up in a part of the sea where, according to the account of experienced seamen, the water before had been about a hundred fathoms in depth. Its distance from Iceland was sixteen, and from Bird Island eight miles. In the month of August it threw up bright flames; and it continued to burn till February 1784. Later accounts state that towards the end of the year it threw up a large column of fire intermixed with sand. This island was about half a mile in circumference, and its height appeared to be equal to that of the mountain Esian.

Towards the north-west, nearer to Iceland than the old eastern gulph of Greenland, lies another very high island, larger than the former; which, according to the latest ac-

counts, has for a long time burnt day and night. We have been informed also by accounts from Iceland and Norway, that a violent fiery eruption took place in the most distant wilds of Greenland, opposite to the northern part of Iceland; and also in other places, previous to that of the latter above described. This is confirmed by letters dated September the 14th, in which it is said that a violent north wind from the sea had brought over to the northern coast of Iceland abundance of ashes, with a strong sulphureous smell; and this phenomenon continued the whole summer.

The effects of these remarkable phenomena seem to have extended also to other countries. At the time when the before mentioned acrid rain prevailed in Iceland, an uncommonly sharp and penetrating rain of the like kind fell at Drontheim and other parts of Norway. In the Feroe islands this rain burnt as it were the leaves of the trees, and the grafs on the fields had a blackish appearance. When the wind blew from the N.W. great quantities of ashes, sand and sulphureous vapour fell in these islands, though they are eighty miles distant from Iceland; and the sails and decks of several ships, while on their passage between Copenhagen and Iceland, were covered with black sandy dust. Even in Zealand and at Copenhagen the sun, from the beginning of June till the 8th of August, seemed remarkably red; and throughout the whole month of July the atmosphere was so filled with dust and vapour, that the sun could not be seen in the evening after eight or nine o'clock. Even at noon the sun was red, and this was observed in the night-time to be the case with the moon and the stars. The learned Professor Kratzenstein said that these phenomena must proceed from a fiery eruption in Iceland; which was the more remarkable as Iceland lies at the distance of almost 300 miles from Copenhagen, towards the north-west. Others said they arose from the great heats which frequently happened, and particularly on the 27th and 29th of July, and the 5th of August. The earth

at this time was almost incapable of producing either herbs or grafs, and the leaves even withered on the trees. A whitish grey kind of dust was seen to fall towards the ground; and the fields in the night were often overspread with a blueish mist, which was accompanied with a certain pale fiery brightness and a fulphureous smell. During the nights when this fog prevailed, little or no dew fell. Phenomena of the same kind were observed in Germany, Holland, and other countries.

II. *An Account of TOALDO's System respecting the Probability of a Change of Weather at the different Changes of the Moon. From Journal des Sciences Utiles.*

WERE the sun the only cause of the variations of the weather, the regular course of that luminary, from year to year, would produce the same weather in the same seasons. The principal variations of the weather, however, depend upon some other cause not so uniform, the discovery of which has long given employment to philosophers; and as we find that the motion of the sea seems to have an intimate connection with the motion of the moon, it has thence been believed, that the latter acts a principal part, not only in this phenomenon of the flux and reflux, but that it could not produce these variations on the earth, without having, at the same time, a considerable influence on the atmosphere. The difference of the fluids which compose it, and, above all, the great elasticity of the air, can alter this effect, but not entirely destroy it.

It is well known that no philosopher has yet been able, from mere theory, to form any proper conclusion respecting these variations of the weather. To supply this deficiency, M. Toaldo called in the aid of experience, and compared the state of the atmosphere with the situation of the moon, where its activity appeared to be strongest and weakest.

From

From observations made at Padua on this subject, during the course of fifty years, he at length found that good and bad weather have been always determined by certain situations of the moon; and this circumstance furnished him the means of foretelling, with some degree of certainty, the state of the atmosphere by the situation of that luminary deduced from astronomical calculations. He distinguishes ten situations of the moon, each of which is capable of producing a sensible effect on our atmosphere; and, in order to comprehend these, it must be observed, that the motion of the moon has three different relations, from which there arise the same number of revolutions, and that each of these has a particular duration, and at the same time certain situations, as expressed in the following table;

REVOLUTIONS.

SITUATIONS OF THE MOON.

1. *Synodical*, in regard to the sun; continues 29 days 12 hours 44 minutes.

New moon
First quarter
Full moon
Last quarter

2. *Anomalistic*, in regard to the moon's course; continues 27 days 13 hours 43 minutes.

Apogeeum
Perigeum

3. *Periodical*, in regard to the moon's passing the equator; continues 27 days 7 hours 43 minutes.

Ascending equinoxes *
Northern luniflices †
Descending equinoxes
Southern luniflices

* The two passages of the moon over the equator are called by M. Toldo, one the *ascending*, and the other the *descending equinox*. EDIT.

† The two *luniflices*, as M. de la Lande has called them, are: 1st, the *oreal luniflice*, when the moon approaches as near as she can in each lunation to our zenith: 2d, the *austral luniflice*, when she is at the greatest distance from it. EDIT.

The situations of the moon which have a relation to the synodical revolution, are well known. It may, however, be remarked, that new and full moon are called the syzigies, and the first and last quarter the quadratures. The perigeum and apogeum are comprehended under the term apfides.

On account of the difference in the periods of these three revolutions, the situations of the moon do not return in the same order, till after a long series of years; and in the difference of their coincidence, connected with the regular effect of the sun at each season, lies the cause of the different variations of the weather. The following are the rules which M. Toaldo has deduced from his observations.

The probabilities that the weather will change at a certain period of the moon are in the following proportions:

New moon	-	-	-	6 : 1
First quarter	-	-	-	5 : 2
Full moon	-	-	-	5 : 2
Last quarter	-	-	-	5 : 4
Perigeum	-	-	-	7 : 1
Apogeum	-	-	-	4 : 1
Ascending equinox	-	-	-	13 : 4
Northern lunifrice	-	-	-	11 : 4
Descending equinox	-	-	-	11 : 4
Southern lunifrice	-	-	-	3 : 1

That is to say, a person may bet six to one, that the new moon will bring with it a change of weather. Each situation of the moon alters that state of the atmosphere which has been occasioned by the preceding one; and it seldom happens that any change in the weather takes place without a change in the lunar situations. These situations are combined, on account of the inequality of their revolutions, and the greatest effect is produced by the union of the syzigies with the apfides. The proportions of their power to produce variations are as follows:

New moon coinciding with the perigeum	-	33 : 1
Ditto with the apogeum	-	7 : 1
Full moon with the perigeum	-	10 : 1
Ditto with the apogeum	-	8 : 1

The combination of these situations generally occasions storms and tempests ; and this perturbing power will always have the greater effect, the nearer these combined situations are to the moon's passage over the equator, particularly in the months of March and September. At the new and full moons, in the months of March and September, and even at the solstices, especially the winter solstice, the atmosphere assumes a certain character, by which it is distinguished for three, and, sometimes, six months. The new moons which produce no change in the weather, are those that happen at a distance from the apsidæ.

As it is perfectly true that each situation of the moon alters that state of the atmosphere which has been produced by another, it is however observed that many situations of the moon are favourable to good and others to bad weather. Those belonging to the latter class are : the perigeum, new and full moon, passage of the equator, and the northern lunifrice. Those belonging to the former are : the apogeum, quadratures, and the southern lunifrice. Changes of the weather seldom take place on the very days of the moon's situations, but either precede or follow them. It has been found by observation, that the changes effected by the lunar situations in the six winter months precede, and in the six summer months follow them.

Besides the lunar situations to which the above observations refer, attention must be paid also to the fourth day before new and full moon, which are called the octants. At these times the weather is inclined to changes ; and it may be easily seen, that these will follow at the next lunar situation. Virgil calls this fourth day a very sure prophet. If on that day the horns of the moon are clear and well defined,

good

good weather may be expected ; but if they are dull, and not clearly marked on the edges, it is a sign that bad weather will ensue. When the weather remains unchanged on the fourth, fifth and sixth day of the moon, we may conjecture that it will continue so till full moon, even sometimes till the next new moon ; and in that case the lunar situations have only a very weak effect. Many observers of nature have also remarked, that the approach of the lunar situations is somewhat critical for the sick.

Conjectures on the Periods of Rain.

The rising and setting of the moon, as well as its superior and inferior passage of the meridian, may serve as a rule for foretelling the times of rain. M. Toaldo calls these situations the moon's angles.

The times most exposed to rain are the rising and setting ; those most favourable to good weather, the passage of the meridian. It has been remarked that, during rainy days, bad weather is always a little interrupted about the time when the moon passes the meridian. We must, however, make an exception to this rule as often as the angle of the moon does not coincide with that of the sun. As these observations may be very easily made, by means of astronomical tables, in which the angles of the moon and sun are marked, they are exceedingly well calculated to prove the truth of this system. No one, for instance, will refuse assent to it, when the daily changes correspond with the angles of the moon ; and when, independently of the effects of the moon's situation, the horizontal effect of the moon at rising and setting is different from that produced by its passage over the meridian.

It rains oftener in the day time than in the night, and oftener in the evening than in the morning.

Influence of the Moon in regard to extraordinary Years.

Bad years take place when the apsidal of the moon fall in
the

the four cardinal points of the zodiac. Their intervals, therefore, are as 4 to 5, 8 to 9, &c. or as the intervals of the passage of the apsidæ through the four cardinal points of the zodiac. Thus the year 1777 was, in general, a bad year; and in that year the apsidæ of the moon were in the equinoctial signs; and it is probable that the years in which the apsidæ fall in the signs Taurus, Leo, Virgo and Aquarius, will be good and moderate years, as the year 1776 really was; and in that year the apsidæ of the moon were in Taurus and Virgo.

Every eighteenth year must be similar. We, however, can not depend upon a return altogether the same, on account of the three different revolutions of the moon; and therefore it may happen, that the epoch of this extraordinary year may be retarded a year or perhaps two. Though approximations only are here given, this does not prevent their being useful to farmers, if they only pay attention to circumstances. Besides, various exceptions must be made for different parts of the earth; and it is difficult to determine these beforehand, as what regards this system is applicable to the whole globe; but when the result of the system has been improved by local observations, the conjectures for each country will be attended with more certainty.

The fifty-fourth year must have a greater similarity to the first than to all the rest; because, at this period, the situations of the moon, in regard to the sun and the earth, are again found in the same points.

The quantity of the rain which falls in nine successive years is almost equal to that which falls in the next following nine. But this is not the case when we compare in like manner the quantity of rain which falls in six, eight or ten years.

Effects of the Moon on the Barometer.

The variations of the barometer are so intimately connected with changes of the weather, that there is reason to suppose that the moon has some influence on the state of that instrument.

ment. For the sake of more certainty, however, M. Toaldo compared a diary of the state of the barometer, kept for many years, with the situations of the moon, and found the following result : 1st, That the barometer at the time of the moon's apogee rises the sixth part of a line higher than at the perigee ; 2d, that at the time of the quadratures it stands a tenth of a line higher than at the time of the syzies ; and 3d, that it is a fourth of a line higher at the southern lunifice than the northern.

Thus far the comparison of the moon's situations with the state of the barometer agrees perfectly with meteorological observations. This, however, is not the case at the time of the moon's passage through her equinoctial points ; for the heights of the barometer are then greater, chiefly when she passes in Libra : a circumstance which is contrary to meteorological observations, since these situations of the moon indicate bad weather. It must, however, be remarked, that in this contradiction the indications of the moon's situations are more to be depended on than those of the barometer.

It has a like connection with the coincidence of the equinoctial point and the perigee, which also gives heights considerably greater. The union of these points, however, is a sign of great irregularity. It must here be remarked that, according to De Luc, the rapid movement of the barometer indicates a storm of short duration, and that in such a case, even when it rises, bad weather is likely to follow.

M. Toaldo says, that the Europeans, when they first visited Mexico, found a singular custom prevalent in that country. When a new emperor was chosen, he was obliged to swear that, during his government, rain should fall according to the pleasure of his subjects ; that no inundations should be occasioned, and that the fields should not be rendered unfruitful, &c. The multitude imagine that the meteorologist enters into an obligation of the like kind ; but all that can be expected from him is confined merely to conjectural rules respecting changes of the weather ; and even these prognostics,

prognostics, when determined for particular places, must not be considered as free from frequent error, as those causes which act upon the earth, in general, may be much changed by local causes in different districts.

III. *On the present State of Surgery in Turkey. From A Survey of the Turkish Empire. By W. ETON, Esq.*

IT might reasonably be expected that a nation of warriors should have expert surgeons at least, and that they should have paid attention to the improvements and discoveries made by other nations. Nothing of this, however, is the case. They perform no operations, nor will they consent to an European's making an amputation, though the loss of life be a certain consequence of omitting it. Their art is simply confined to healing, and at most extracting a ball and a splinter of a bone. It must be confessed that, as their habit of body is generally healthy, nature performs often wonderful cures. They rely much on balsams, mummy, &c. There is in Constantinople a Persian extraordinary expert in the art of healing. The Arabs bury a person, who has received a wound in his body, up to the neck in hot sand for twenty-four hours; and apply with success the actual cautery for the dropsy.

I saw in the eastern parts of the empire a method of setting bones practised, which appears to me worthy of the attention of surgeons in Europe. It is by inclosing the broken limb, after the bones are put in their places, in a case of plaster of Paris (or gypsum) which takes exactly the form of the limb, without any pressure, and in a few minutes the mass is solid and strong. If it be a compound fracture, the place where the wound is, and out of which an exfoliated bone is to come, may be left uncovered, without any injury to the strength of the plaster encasement. This substance may be easily cut with a knife, and removed, and replaced with

with another. If, when the swelling subsides, the cavity is too large for the limb, a hole or holes being left, liquid gypsum plaster may be poured in, which will perfectly fill up the void, and exactly fit the limb. A hole may be made at first by placing an oiled cork or bit of wood against any part where it is required; and when the plaster is set, it is to be removed. There is nothing in gypsum injurious, if it be free from lime; it will soon become very dry and light, and the limb may be bathed with spirits, which will penetrate through the covering. Spirits may be used instead of water, or mixed with it (or vinegar) at the first making of the plaster.

I saw a case of a most terrible compound fracture of the leg and thigh, by the fall of a cannon, cured in this manner. The person was seated on the ground, and the plaster case extended from below his heel to the upper part of his thigh, whence a bandage, fastened into the plaster, went round his body. He reclined back when he slept, as he could not lie down. During the cure, where they saw matter or moisture appear through the plaster coating, they cut a hole with a knife to dress the wound, or let out the matter more freely.

On this occasion I cannot help mentioning the treatment of parts frozen in Russia, not by the surgeons, but by the common people, the success of which I was an eye-witness to in several cases, as well as to the failure of the common mode of treating frozen parts by the most able surgeons of the army. I shall simply state the facts I relate to.

After Ochakof was taken, I received into my subterranean lodging as many prisoners as it would contain, all of whom were either wounded or had a limb frozen. Among them were two children, one about six and the other about fourteen years of age; the latter had one of her feet frozen to the ankle, the other all the toes and the sole of one of her feet. The second day the parts appeared black, (the first day they were not much observed.) The French surgeon,

whom Prince Potemkin had sent for purposely from Paris, and who was a man of note, ordered them to be constantly bathed with warm canphorated spirits: the elder was removed to the hospital, when a mortification began; the younger I kept, and as we removed into winter quarters, I carried the child along with me. The mortified parts separated, the bones of the toes came off, and, after a considerable time, the sores healed. I should have said, the surgeon was for immediately amputating both the limbs.

In a subterranean room, not far from mine, were several women whose feet had been in a like manner frozen; but as no surgeon attended them, the Russian soldiers and waggoners undertook the cure. It was also the second day when they applied their remedy, and the parts were perfectly black. This remedy was goose-grease, with which the parts were smeared warm, and the operation often repeated: their directions were, never to let the parts be dry, but always covered with grease. The consequence was, that by degrees the circulation extended lower down, and the blackness decreased, till, last of all, the toes were only discoloured, and at length circulation was restored to them.

I can account for this no otherwise, than that the fat kept the pores shut, and prevented the air from promoting putrefaction; in the meantime the vessels were continually absorbing part of the stagnated blood, till by degrees the whole circulation was restored. It is known that extravasated and stagnated blood will remain a long time in the body without putrifying, if it be not exposed to the air. I conclude also, that in these cases of frost, the mortification first begins on the surface, which is in contact with the air.

I only meant, however; to relate facts, and leave it to others to account for them.

This is a general practice of the peasants throughout all Russia; but if a part is discovered to be frozen, *before the person comes into a warm room*, the frost may be extracted by plunging the part into cold water, or rubbing it with snow till the circulation returns.

IV. *Account of the Method of Catching Wild Elephants at Tipura in the East Indies.* By JOHN CORSE, Esq. From *The Asiatic Researches.*

[Concluded from page 12.]

HAVING now related, partly from my own knowledge, and partly from comparing the accounts given by different people employed in this business, the manner in which the male elephants, called Goondahs, are secured; I shall next, entirely from my own knowledge, describe the methods I have seen employed for securing a herd of wild elephants. Female elephants are never taken singly, but always in the herd, which consists of young and old of both sexes. This noble, docile, and useful animal, seems naturally of a social disposition, as a herd in general consists of from about 40 to 100, and is conducted under the direction of one of the oldest and largest females, called the Palmai, and one of the largest males. When a herd is discovered, about 500 people are employed to surround it, who divide themselves into small parties, called Chokeys, consisting generally of one Mahote and two Coolies, at the distance of twenty or thirty yards from each other, and form an irregular circle in which the elephants are inclosed: each party lights a fire and clears a foot-path to the station that is next him, by which a regular communication is soon formed through the whole circumference from one to the other. By this path reinforcements can immediately be brought to any place where an alarm is given; and it is also necessary for the superintendants, who are always going round to see that the people are alert upon their posts. The first circle (the Dawkee) being thus formed, the remaining part of the day and night is spent in keeping watch by turns, or in cooking for themselves and companions. Early next morning one man is detached from each station, to form another circle in that direction where they wish the elephants to advance. When

it is finished; the people stationed nearest to the new circle put out their fires and file off to the right and left, to form the advanced party, thus leaving an opening for the herd to advance through; and by this movement, both the old and new circle are joined and form an oblong. The people from behind now begin shouting and making a noise with their rattles, tomtoms, &c. to cause the elephants to advance; and as soon as they are got within the new circle, the people close up, take their proper stations, and pass the remaining part of the day and night as before. In the morning the same process is repeated; and in this manner the herd advances slowly in that direction where they find themselves least incommoded by the noise and clamour of the hunters, feeding, as they go along, upon branches of trees, leaves of bamboos, &c. which come in their way. If they suspected any snare, they could easily break through the circle; but this inoffensive animal, going merely in quest of food, and not seeing any of the people who surround him, and who are concealed by the thick jungle, advances without suspicion, and appears only to avoid being pestered by their noise and din. As fire is the thing elephants seem most afraid of in their wild state, and will seldom venture near it, the hunters always have a number of fires lighted, and particularly at night, to prevent the elephants coming too near, as well as to cook their victuals and keep them warm. The sentinels supply these fires with fuel, especially green bamboos, which are generally at hand, and which, by the crackling and loud report they make, together with the noise of the watchmen, deter the elephants from coming near; so that the herd generally remains at a distance near the centre of the circle. Should they at any time advance, the alarm is given, and all the people immediately make a noise and use their rattles to make them keep at a greater distance. In this manner they are gradually brought to the Keddah, or place where they are to be secured. As the natives are extremely slow in their operations, they seldom

bring the herd above one circle in a day, except on an emergency, when they exert themselves and advance two circles. They have no tents or covering but the thick woods, which, during the day, keep off the rays of the sun; and at night they sleep by the fires they have lighted, upon mats spread on the ground, wrapt up in a piece of coarse cloth. The season is then so mild that the people continue very healthy; and an accident seldom happens except to stragglers about the outskirts of the wood, who are sometimes, though very rarely, carried off by tigers. The Keddah, or place where the herd is to be secured, is differently constructed in different places; here it consists of three enclosures, communicating with each other by means of narrow openings or gateways. The outer enclosure, or the one next to the place where the elephants are to enter, is the largest; the middle one is generally, though not always, the next in size; and the third, or furthestmost, is the smallest. These proportions, however, are not always adhered to in the making of a Keddah, nor indeed does there appear to me any reason for making three enclosures: but as my intentions are merely to relate facts, I shall proceed to observe, that when in the third or last enclosure, the elephants are then only deemed secure; here they are kept six or eight days, and are regularly though scantily fed from a scaffold on the outside, close to the entrance of an outlet called the Roomee, which is about sixty feet long and very narrow, and through which the elephants are to be taken out one by one. In many places this mode is not adopted; for, as soon as the herd has been surrounded by a strong palisade, Koomkees are sent in with proper people, who tie them on the spot, in the same manner as was mentioned above of the Goondahs, or male elephants, that are taken singly. These enclosures are all pretty strong; but the third is the strongest, nor are the elephants deemed secure, as already observed, till they have entered it. This enclosure has, like the other two, a pretty deep ditch on the inside; and, upon the

the bank of earth, that is thrown up from the excavation, a row of strong palisades of middle-sized trees is planted, strengthened with cross bars, which are tied to them about the distance of fourteen inches from each other; and these are supported on the outside by strong posts like buttresses, having one end sunk in the earth and the other pressing against the cross bars to which they are fastened. When the herd is brought near to the first enclosure, or Baigcote, which has two gateways towards the jungle, from which the elephants are to advance, (these, as well as the other gateways, are disguised with branches of trees and bamboos stuck in the ground so as to give them the appearance of a natural jungle,) the greatest difficulty is to get the herd to enter the first or outer enclosure; for, notwithstanding the precautions taken to disguise both the entries as well as the palisade which surrounds this enclosure, the Palmai, or leader, now appears to suspect some snare, from the difficulty and hesitation with which in general she passes into it; but, as soon as she enters, the whole herd implicitly follows. Immediately, when they are all passed the gateway, fires are lighted round the greatest part of the enclosure, and particularly at the entries, to prevent the elephants from returning. The hunters from without then make a terrible noise by shouting, beating of tomtoms (a kind of drum), firing blunt cartridges, &c. to urge the herd on to the next enclosure. The elephants, finding themselves ensnared, scream and make a noise; but, seeing no opening except the entrance to the next enclosure, and which they at first generally avoid, they return to the place through which they lately passed, thinking perhaps to escape, but now find it strongly barricaded; and as there is no ditch at this place, the hunters, to prevent their coming near and forcing their way, keep a line of fire constantly burning all along where the ditch is interrupted, and supply it with fuel from the top of the palisade; and the people from without make a noise, shouting and

hallooing, to drive them away. Whenever they turn, they find themselves opposed by burning fires, or bundles of reeds and dried grass, which are thrust through the opening of the palisades, except towards the entrance of the second enclosure, or Doobraze-cote. After traversing the Baigcote for some time, and finding no chance of escaping but through the gateway into the next enclosure, the leader enters, and the rest follow: the gate is instantly shut by people who are stationed on a small scaffold immediately above it, and strongly barricaded, fires are lighted, and the same discordant din made and continued, till the herd has passed through another gateway into the last enclosure, or Rajecote, the gate of which is secured in the same manner as the former was. The elephants, being now completely surrounded on all sides, and perceiving no outlet through which they can escape, appear desperate, and in their fury advance frequently to the ditch in order to break down the palisade, inflating their trunks, screaming louder and shriller than any trumpet, sometimes grumbling like the hollow murmur of distant thunder; but wherever they make an attack, they are opposed by lighted fires, and by the noise and triumphant shouts of the hunters. As they must remain some time in this enclosure, care is always taken to have part of the ditch filled with water, which is supplied by a small stream, either natural, or conducted through an artificial channel from some neighbouring reservoir. The elephants have recourse to this water to quench their thirst and cool themselves after their fatigues, by sucking the water into their trunks, and then squirting it over every part of their bodies. While they remain in this enclosure, they continue sulky, and seem to meditate their escape; but the hunters build huts, and form an encampment as it were around them, close to the palisade; watchmen are placed, and every precaution used to prevent their breaking through. This they would soon effect, if left to themselves, notwithstanding the
palisade

palisade is made of very strong stakes sunk into the earth on the outside of the ditch, and strengthened by cross bars and buttresses as already mentioned.

When the herd has continued a few days in the Keddah, the door of the Roomee is opened, into which some one of the elephants is enticed to enter, by having food thrown first before, and then gradually further on into the passage, till the elephant has advanced far enough to admit of the gate's being shut. Above this wicker-gate, or door, two men are stationed on a small scaffold, who throw down the food. When the elephant has passed beyond the door, they give the signal to a man who from without shuts it by pulling a string, and they secure it by throwing two bars that stood perpendicular on each side, the one across the other thus X, forming the figure of St. Andrew's Cross; and then two similar bars are thrown across each other behind the door next to the Keddah, so that the door is in the centre: for farther security, horizontal bars are pushed across the Roomee, through the openings of the palisades, both before and behind those crosses, to prevent the possibility of the door's being broken. The Roomee is so narrow that a large elephant cannot turn in it; but as soon as he hears the noise that is made in shutting the gate, he retreats backwards, and endeavours to force it: being now secured in the manner already noticed, his efforts are unavailing. Finding his retreat thus cut off, he advances and exerts his utmost force to break down the bars, which were previously put across a little farther on in the outlet, by running against them, screaming and roaring, and battering them, like a ram, by repeated blows of his head, retreating and advancing with the utmost fury. In his rage he rises and leaps upon the bars with his fore-feet, and strives to break them down with his huge weight. In February 1788 a large female elephant dropt down dead in the Roomee, from the violent exertions she made. When the elephant is somewhat fatigued by

these exertions, strong ropes * with running nooses are placed in the outlet by the hunters; and as soon as he puts a foot within the noose, it is immediately drawn tight and fastened to the palisades. When all his feet have been made pretty fast, two men place themselves behind some bars that run across the Roomie to prevent his kicking them, and with great caution tie his hind-legs together, by passing a cord alternately from the one to the other, like the figure 8, and then fastening these turns as above described. After this the Pharah, Dools, &c. are put on in succession, in the same manner as on the Goondah, only that here the people are in greater security. While these ropes are making fast, the other hunters are careful not to go too near, but keep on the outside of the palisade, and divert his attention as much as they can from those employed in fastening them, by supplying him with grass, and sometimes with plantain-leaves and sugar-canes, of which he is remarkably fond, by presenting a stick, giving him hopes of catching it, or by gently striking or tickling his proboscis. He frequently, however, seizes the ropes with his trunk, and endeavours to break them, particularly those with which his feet are tied, and sometimes tries to bite them through with his grinders (as he has no incisors or front teeth); but the hunters then goad him with sharpened bamboos, or light spears, so as to make him quit his hold. Those who are employed in putting the ropes around his body, and over his head, stand above him, on a small kind of platform, consisting of a few bars run across through the openings of the palisades; and as an elephant cannot see any thing that is above, and rather behind his head, they are very little incommoded by him, although he appears to smell them, and endeavours to catch them with his trunk. When the whole apparatus is properly secured, the ends of the two cables (Dools) which

* These are of the same form and size nearly as the Phands, but much shorter in proportion.

were fastened round his neck, are brought forward to the end of the Roomée, where two female elephants are waiting; and to them these cables are made fast. When every thing is ready, the door at the end of the outlet is opened, the cross bars are removed, and the passage left clear. The ropes that tied his legs to the palisades are loosened, and, if he does not advance readily, they goad him with long poles sharpened at the ends or pointed with iron, and urge him on with their noise and din, and at the same time the females pull him gently forward: as soon as he has cleared the Roomée, his conductors separate; so that if he attempts to go to one side, he is prevented by the elephant that pulls in the opposite direction, and *vice versa*. The Bundahs which tie his hind legs, though but loosely, yet prevent his going fast; and, thus situated, he is conducted like an enraged bull, that has a cord fastened to his horns on each side, so that he cannot turn either to the right or left to avenge himself. In like manner is this noble animal led to the next tree, as the Goondahs before mentioned were. Sometimes he becomes obstinate, and will not advance; in which case, while one of his conductors draws him forward, the other comes behind and pushes him on: should he lie down, she puts her snout under and raises him up, supporting him on her knee, and with her head pushing him forward with all her strength; the hunters likewise assist by goading him, and urging him forward by their noise and din; sometimes they are even obliged to put lighted torches near, in order to make him advance. In conducting small elephants from the Roomée, only one cable and one Koomkee are made use of. As soon as each elephant is secured, he is left in charge to the Mahote, or keeper, who is appointed to attend and instruct him; and, under him, there are from two to five Coolies, according to the size of the elephant, in order to assist and to supply food and water, till he becomes so tractable as to bring the former himself. These people erect a small hut immediately before him, where the Mahote,

or one of the Coolies, constantly attends, supplies him with food, and soothes and caresses him by a variety of little arts. Sometimes the Mahote threatens and even goads him with a long stick pointed with iron, but more generally coaxes and flatters him, scratching his head and trunk with a long bamboo split at one end into many pieces, and driving away the flies from any sores occasioned by the hurts and bruises he got by his efforts to escape from the Roomee. This animal's skin is soft, considering his great size; is extremely sensible, and is easily cut or pierced, more so than the skin of most large quadrupeds. The Mahote likewise keeps him cool, by squirting water all over him, and standing without the reach of his trunk: in a few days he advances cautiously to his side, and strokes and pats him with his hand, speaking to him all the while in a soothing tone of voice, and in a little time he begins to know his keeper and obey his commands. By degrees the Mahote becomes familiar to him, and at length gets upon his back from one of the tame elephants, and, as the animal becomes more tractable, he advances gradually forward; towards his head, till at last he is permitted to seat himself on his neck, from which place he afterwards regulates and directs all his motions. While they are training in this manner, the tame elephants lead out the others in turn, for the sake of exercise, and likewise to ease their legs from the cords with which they are tied, and which are apt to gall them most terribly unless they are regularly slackened and shifted. In five or six weeks the elephant becomes obedient to his keeper; his fetters are taken off by degrees, and generally in about five or six months he suffers himself to be conducted by the Mahote from one place to another: care, however, is always taken not to let him approach his former haunts, lest a recollection of the freedom he there enjoyed should induce him again to recover his liberty. This obedience to his conductor seems to proceed partly from a sense of generosity, as it is in some measure voluntary; for, whenever

an elephant takes fright, or is determined to run away, all the exertions of the Mahote cannot prevent him, even by beating or digging the pointed iron hook into his head, with which he directs him; on such an occasion the animal seems to disregard these feeble efforts, otherwise he would shake or pull him off with his trunk, and dash him in pieces. Accidents of this kind happen almost every year, especially to those Mahotes who attend the large Goondahs; but such accidents are in general owing entirely to their own carelessness and neglect. It is necessary to treat the males with much greater severity than the females, to keep them in awe; but it is too common a practice among the Mahotes, either to be negligent in using proper measures to render their elephants docile, or to trust too much to their good nature before they are thoroughly acquainted with their dispositions. The iron hook, with which they direct him, is pretty heavy, about sixteen inches long, with a straight spike advancing a little beyond the curve of the hook, so that altogether it is exactly like that which ferrymen or boatmen use fastened to a long pole.

In this account of the process for catching and taming elephants, I have used the masculine gender to avoid circumlocution, as both males and females are treated in the same manner: the former are seldom so docile, but, like the males of other animals, are fiercer, stronger, and more untractable than the females.

Before I conclude, it may be proper to observe, that young elephants suck constantly with their mouths, and never with their trunks*, as Buffon has asserted; a conclusion he made merely from conjecture, and the great and various uses to which they are well adapted and applied by every elephant.

* Aristotle says expressly, that the young elephants suck with their mouths, and not with their trunks: 'Ο δε σκυμνος όταν γεννηται θηλαζει τῷ στοματι οὐ τῷ μυκτηρι. Aristot. Opera. Basilæ 1500. fol. p. 494. EDIT.

I have seen young ones from one day to three years old sucking their dams, but never saw them use their trunks, except to press the breast, which, by natural instinct, they seemed to know would make the milk flow more readily. The mode of connection between the male and female is now ascertained beyond the possibility of a doubt; as Mr. Buller, Lieut. Hawkins, and many others, saw a male copulate with a female, after they were secured in the Keddah, in a manner exactly similar to the conjunction of the horse with a mare.

This fact entirely overturns what has been so often related concerning the supposed delicacy of this useful animal, and a variety of other hypotheses, which are equally void of foundation. As far as I know, the exact time an elephant goes with young, has not yet been ascertained, but which cannot be less than two years, as one of the elephants brought forth a young one twenty-one months and three days after she was taken. She was observed to be with young in April or May 1788, and she was only taken in January preceding; so that it is very likely she must have had connection with the male some months before she was secured, otherwise they could not discover that she was with young, as a foetus of less than six months cannot well be supposed to make any alteration in the size or shape of so large an animal. The young one, a male, was produced October 16th, 1789, and appeared in every respect to have arrived at its full time. Mr. Harris, to whom it belongs, examined its mouth a few days after it was brought forth, and found that one of its grinders on each side had partly cut the gum. It is now alive and well, and begins to chew a little grass.

I have further to remark, that one of the tusks of the young elephant has made its appearance; so that we can now ascertain it to be of that species called Mucknah, the tusks of which are always small, and point nearly straight downwards.

downwards. He was thirty-five inches high at his birth, and is now thirty-nine; so that he has grown four inches in nearly as many months. Elephants are always measured at the shoulder; for the arch or curve of the back, of young ones particularly, is considerably higher than any other part, and it is a sure sign of old age whenever this curve is found flattened or considerably depressed, after an elephant has once attained his full growth.

Though these remarks, as well as several others in the above relation, do not come within the plan I proposed, which was merely to describe the method of taking wild elephants in the province of Tipura, yet I hope they will not be deemed impertinent or superfluous, especially as several of them tend to establish some important facts in the natural history of this animal, that are not known, or not attended to, at least in any accounts that I had an opportunity of seeing.

V. *Observations on the bodily Conformation and mental Capacity of the Negroes.* By Professor BLUMENBACH. From *Magazin für das neueste aus der Physik, Vol. IV.*

DURING a tour which I made through Swisserland, I saw in the picture-gallery at Pommersfeld four negro heads by Vandyk, two of which in particular had the lines of the face so regular that the features seemed very little different from the European. At that time, as I had never had an opportunity of acquiring a proper knowledge respecting the form of the negro head and cranium, by studying nature, and as I remembered that Mr. Camper, in a dissertation read in the Academy of Painting at Amsterdam, had mentioned that the greater part of the most eminent painters, and especially Rubens, Vandyk and Jordaens, when they painted Moors, copied from Europeans, whose faces had been blackened for that purpose, I ascribed the European look of the

above negro heads to this common fault. Some months after, however, I had an opportunity of convincing myself that there are real negroes whose features correspond very nearly with those of the Europeans, and that the above heads in the gallery of Pommersfeld might be a true representation of nature.

Going to pay a visit at Yverdon to the two brothers Treytorrens, one of whom, the chevalier, had been thirty-five years in the French service, particularly at St. Domingo; and the other, by means of the opportunities which his brother enjoyed, had a collection of natural curiosities that contained many rare articles, when I entered the court of their elegant habitation, which is situated on the road to Goumoens, I saw no person to shew me into the house, except a woman of an agreeable figure, who was standing with her back towards me. When she turned round to give me an answer, I was much surprised to find that she was a female negro, whose face perfectly corresponded with her figure, and fully justified the fidelity of likeness in Vandyk's negro heads, which I had seen at Pommersfeld. All the features of her face, even the nose and lips, the latter of which were a little thick, though not so as to be disagreeable, had they been covered with a white skin, must have excited universal admiration. At the same time she was not only exceedingly lively, and possessed a sound understanding; but, as I afterwards learned, was extremely well informed and expert in the obstetric art. The handsome pretty negress of Yverdon is celebrated far and near as the best midwife in the Italian part of Switzerland. I was informed by her master, the chevalier, who has in his service also a negro man as elegantly formed as a statue, that she was a creole from St. Domingo; that both her parents were natives of Congo, but not so black as the negroes of Senegal.

Since that period I have had an opportunity of seeing and conversing with many negroes, and have procured for my collection a great many anatomical preparations from negro
bodies,

bodies, which, together with what I have read in different voyages, tend more and more to convince me of the truth of the two following propositions :

1. That between one negro and another there is as much (if not more) difference in the colour, and particularly in the lineaments of the face, as between many real negroes, and other varieties of the human species.

2. That the negroes, in regard to their mental faculties and capacity, are not inferior to the rest of the human race.

The three negro skulls, which I have now before me, afford, by the very striking gradation with which the lineaments pass from the one to the other, a very evident proof of the first proposition. One of them, which Mr. Michaelis was so good as to bring me from New-York, and of which I have given an accurate description in another place *, is distinguished by such a projecting upper jaw-bone, that, if the same peculiarity belonged to all negroes, one might be tempted to suppose that they had another first parent than Adam. On the other hand, the lineaments of the third have so little of the exotic form, and are so different from the first, that if I had not dissected the whole head perfectly entire, and just as it was when cut from the body, I should be in doubt whether I ought to consider it as having actually belonged to a real negro. The second holds a mean rank between both, and in its whole form has a great likeness to the head of the Abyssinian Abbas Gregorius, a good engraving of which by Heifs, in 1691, from a painting by Von Sand, I have now before me, and which not only proves in general the close affinity of the Abyssinians with the negroes, but approaches much nearer to the ugly negroes, to speak according to the European ideas of beauty, than the well-formed negresses of Yverdun, or the handsome young negro whose head I dissected as before mentioned, or than a thousand others whose features are little different from those of the Europeans. What I have here said is indeed nothing else than a confirmation of a truth long

* In my *Osteology*, p. 87.

known, which has been already remarked by unprejudiced travellers, as will appear by the following quotations. Le Maire, in his Voyage to Cape Verd, Senegal, and Gambia*, says: "Blackness excepted, there are female negroes as well made as our ladies in Europe." Leguat, in his well-known Voyages†, tells us, that he found at Batavia several very pretty negresses, whose faces had the perfect European form. Adanson, in his Account of Senegal‡, speaking of the female negroes there, has the following passage: "The women are almost as tall as the men, and equally well made. Their skin is remarkably fine and soft: their eyes are black and open; the mouth and lips small, and the features are well proportioned. Some of them are perfect beauties. They are exceedingly lively, and have an easy, free air, that is highly agreeable." Ulloa, in his *Noticias Americanas*||, observes, that some of the negroes have thick projecting lips, a flat nose, eyes deeply sunk in the sockets, which in general are called *getudos*, and wool instead of hair. He then adds: "Others, whose colour is equally black, have features perfectly like those of the whites, particularly in regard to the nose and the eyes, and smooth but thick hair§."

* Voyages aux Cap Verd, Senegal et Gambie, p. 161.

† Vol. ii. p. 136.

‡ Page 22.

|| Page 92.

§ The following observations of an intelligent Danish traveller may serve still farther to confirm the truth of Professor Blumenbach's proposition: "Almost all the negroes are of a good stature, and the Akra negroes have remarkably fine features. The contour of the face, indeed, among the generality of these people, is different from that of the Europeans; but at the same time faces are found among them which, excepting the black colour, would in Europe be considered as beautiful. In common, however, they have something apish. The cheek-bones and chin project very much; and the bones of the nose are smaller than among the Europeans. This last circumstance has probably given rise to the assertion, that the negro women flatten the noses of their children as soon as they are born. But noses may be seen among some of them as much elevated and as regular as those of the Europeans. Their hair is woolly, curled and black, but sometimes red. When continually combed, it may be brought to the length of half a yard; but it never can be kept smooth. See P. E. Hæft Reis na Guinea. Dordrecht 1790. p. 175. EDIT.

The testimonies and examples which serve to prove the truth of the second proposition, respecting the mental faculties, natural talents and ingenuity of the negroes, are equally numerous and incontrovertible. Their astonishing memories, their great activity, and their acuteness in trade, particularly with gold dust, against which the most experienced European merchant cannot be too much on his guard, are all circumstances so well known; that it is not necessary to enlarge on them*. The great aptitude of the slaves for learning every kind of nice handicraft is equally well known; and the case is the same in regard to their musical talents, as we have instances of negroes playing the violin in so masterly a manner, that they gained so much money as enabled them to purchase their liberty†.

Of the poetical genius of the negroes instances are known among both sexes. A female negro, who was a poetess, is mentioned by Haller; and a specimen of the Latin Poetry of Francis Williams, a negro, may be found in the History of Jamaica. The interesting letters of Ignatius Sancho, a negro, are well known; and the two following instances will serve as a farther proof of the capacity and talents of our black brethren, in regard to literature and science. The protestant clergyman J. J. Eliza Capitein was a negro; a man of considerable learning, and a great orator. I have in my possession an excellent print of him engraved by Tanjé, after P. Vandyk. Our worthy professor Hollman, when he was at Wittenberg, conferred the degree of Doctor of Phi-

* Barbot, in his Description of the Coasts of North and South Guinea, to be found in the fifth volume of Churchill's Collection, relates many interesting things on this subject. Thus he says, p. 235. "The blacks are for the most part men of sense and wit enough, of a sharp ready apprehension, and an excellent memory beyond what is easy to imagine; for, though they can neither read nor write, they are always regular in the greatest hurry of business and trade, and seldom in confusion."

† See Urlsperger's *Americanisch Ackerwerk Gottes*, p. 311.

lophony on a negro who had shewn himself to advantage, not only as a writer, but as a teacher, and who afterwards came to Berlin as a counsellor of state to his Prussian majesty. I have now before me two treatises written by him*, one of which, in particular, displays extensive and well-digested reading of the best physiological works of the time. Of the uncommon knowledge which many negroes have had in the practice of medicine, very favourable testimony has been given by Boerhaave and De Haen, who were certainly competent judges; and the sound skill and delicate expertness of the Yverdun accoucheuse are, as already said, celebrated throughout the whole neighbourhood.

To conclude, the Academy of Sciences at Paris had among the number of its correspondents M. Lislet a negro, in the Isle of France, who excelled in making accurate meteorolo-

* One of them is entitled: *Dissert. inaug. philosophica de humanæ mentis ætædia, sive sensûs ac facultatis in mente humana absentia, et earum in corpore nostro organico ac vivo præsentia, quam Præs. D. MART. GOTTH. LOESCHERO publicè defendit auctor ANT. GUIL. AMO, Guinea-Afer, Phil. et A.A. L.L. Mag. et J. V. C. Wittebergæ 1734, m. Apr.* The title of the other is: *Disp. philosophica, continens ideam distinctam eorum quæ competunt vel menti vel corpori nostro vivo et organico, quam Præs. M. ANT. GUIL. AMO, Guinea-Afro, d. 29. Maii 1734, defendit Jo. THEODOS, Meiner Rochliz-Misnie. Philos. et J. V. Cultor.* In an account of Amo's life, printed on this occasion in name of the Academic Council, it is said, among other things respecting his talents: "Honorem, meritis ingenii partum, insigni probitatis, industriæ, eruditionis, quam publicis privatisque exercitationibus declaravit, laude auxit—Compluribus philosophiam domi tradidit excussis tam veterum, quam novorum, placitis, optima quæque selegit, selecta enucleatè ac dilucidè interpretatus est." And the president, in defending the first mentioned treatise, says expressly, in the annexed congratulation to Amo, "Tuum potissimum eminet ingenium felicissimum—utpote qui istius felicitatem ac præstantiam, eruditionis ac doctrinæ soliditatem ac elegantiam, multis speciminibus hætenus in nostra etiam academia magno cum applausu omnibus bonis, et in præsentî dissertatione egregiè comprobasti. Reddo tibi illam proprio marte eleganter ac eruditè elaboratam, integram adhuc et planè immutatam, ut vis ingenii tui eo magis exinde elucescat.

gical observations. On the other hand, whole provinces of Europe might, in my opinion, be named, from which it would be difficult to produce at present virtuoso's, poets, philosophers, and correspondents of a learned academy.

VI. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE. From Journal des Mines. No. XX.

[Continued from page 41.]

CHAP. VI.

Observations to be made on Rivers and other Currents of Water.

1. **E**XTENT of their course, and their inclination from their sources to their mouth.
2. Their dimensions, breadth, depth and velocity in the different parts of their course.
3. Quantity of their periodical increase and decrease at different seasons; their temperature during these seasons; and the causes of these variations.
4. Limits and causes of their extraordinary inundations.
5. Whether they are navigable, and to what distance from their mouth?
6. The nature, purity, and salubrity of their waters.
7. The nature of the sand or mud which they carry along with them; and to what distance they may be traced on the banks or at the bottom of the sea where their mouths are situated. M. Besson even wishes that the traveller should be furnished with a wooden vessel (*sebille*) to wash the sand and separate the more ponderous particles, which may consist of metal or precious stones. The motion of the waves is also

often sufficient to separate, in distinct bands or zones, particles of different gravity *.

8. Nature of the rolled pebbles found on their borders.

9. The quantity and kinds of fish by which they are characterised.

10. To enquire, as in regard to the sea, whether it appears that they contain more or less water than formerly, and whether they have changed their courses.

11. As the greater part of these questions may be applied to lakes, it is not necessary to make them the subject of a separate chapter. I shall insist only on their nature and the measure of their depth; on the temperature of their bottom compared with that at their surface in different seasons; and also on the vestiges of their extent and height in the remotest ages, compared with their present state.

C H A P. VII.

Observations to be made on the Plains.

1. The extent, limits and inclination of a plain; its height above the level of the sea; its relation with the hills or mountains by which it is bordered. To form a proper idea of it as a whole, it would be necessary to ascend some eminence commanding a view over it.

2. The vegetable earth; its nature and thickness in different parts, compared with the time since it has been cultivated, with its productions, and the kind of culture. The nature of the basis on which that earth rests.

3. Rolled pebbles. (*See Chap. VIII.*)

4. Sand, argil; their nature; thickness of their beds.

5. Nature and thickness of the strata of the earth at the greatest depth possible to be reached, by taking advantage of the time when wells, mines and other excavations are dug.

* Moyens de rendre utiles les voyages des naturalistes. *Esprit des Journaux*, Avril 1794.

This research is particularly interesting when these excavations are extended below the level of the sea.

6. Marl-pits; their external appearances; whether they contain shells, and of what kinds; extent of their beds, and their thickness; analysis of them, at least with acetous acid; the uses for which the marl is employed.

7. Clay-pits; quarries of lime-stone, gypsum; mines of coal, &c.

8. Whether the plains exhibit at their surface, or contain in the interior parts of the earth, vestiges of marine bodies, petrified wood, bones or other substances foreign to the soil and to the country.

9. Internal temperature of the earth, ascertained either by direct experiments, or by observing that of the deepest wells or cellars; or by that of springs, which do not freeze in winter, and which remaining cool in summer, seem to come from the greatest depths.

10. Whether any fact can be observed which might oblige us to have recourse to the hypothesis of a central fire.

11. Basins surrounded by hills or mountains; whether they seem to have been formerly filled with water; whether the water appears to have been fresh or salt; whether any thing indicates the period of its retreat, and if there are any traces of the apertures through which it escaped.

CHAP. VIII.

Observations to be made on Rolled Pebbles.

1. The nature and size of those found in any particular district.

2. To examine, above all, whether there is any kind which may be considered as peculiar to that district, or which may be proper to characterise it; or even, whether the absence of any kind or class might not be sufficient to form that character.

3. Whether those found on the borders of any river might be considered as having been thrown up by that river, or whether it only exposed them to view by washing away the soil which it watered.

4. After establishing the character of the pebbles of a certain-district, one might follow, as it were, their traces, and form conjectures both respecting their origin and the route they have pursued.

5. The increase of their size will shew that they approach their origin, or *vice versa*; but care must be taken that other veins of pebbles crossing the former may not conceal the course of those which you are tracing out.

6. A consideration of the pebbles, and still more that of rolled blocks, or, at least, such as are foreign to the soil which bears them; of the height at which they are found, and of the large valleys opposite to their present situation, may afford some indications of the direction, size and force of the currents produced by the grand revolutions of the earth.

7. A consideration of those blocks which rest on solid rock, and which seem still to occupy the place where they were deposited, may, by the state of these rocks, give an idea of the time elapsed since their arrival.

8. How far can the transportation of these great blocks to considerable distances be considered as a general phenomenon? or, is it only a particular phenomenon, arising from some local cause?

9. Can it be believed that such of those blocks as at present occupy elevated sites on mountains, have been transported by billows or waves, which raised them gradually from the bottom of the valleys, and that they must at first have descended to these elevated situations*?

10. Or was it by enormous tides, of eight hundred toises,

* May not the transportation of these blocks, at least in cold countries, be ascribed sometimes to floating ice? C.

for example, that these blocks were transported to the tops of the mountains?

CHAP. IX.

On Mountains in general.

1. To consider whether a mountain be insulated, or whether it forms part of an assemblage of mountains connected with each other in the form of groups or chains.

2. If it be a group, to determine its form and dimensions, and the manner in which its parts are connected.

3. If it be a chain, to determine its direction, its breadth, and its extent; whether it be single or compound; and, in the latter case, the nature and disposition of the partial chains which enter into its composition.

4. If a mountain be insulated or considered separately from its chain, or the group of which it forms a part, to determine its form, its height, and other dimensions.

5. To determine the form and situation of its summit or most elevated part; those of its declivities and bottom.

6. The situation of its precipices in regard to the sea and the nearest plains, valleys, and mountains*.

7. Its nature, and the kind of stone of which it is composed. Whether it be homogeneous; that is to say, of the same nature throughout all its parts; if it be not, to determine the dimensions of its different parts.

8. Whether it consists of indivisible masses, or masses divided by strata.

9. Whether it contains mines either in veins or strata: the nature of these mines.

10. To observe the height at which the snow is perpetual, or what Bouguer calls *the lower limits of the snow*, and the height at which trees, shrubs, and plants, with distinct flowers, cease to grow. These observations have been neglected in the northern countries.

* And in regard to the four cardinal points; whether any side is more steep than another, and which side? C.

11. To observe carefully the increase or decrease of the glaciers: to determine them, in particular, by what are called *moraines*, that is to say, those heaps of stones now or formerly deposited by the glaciers on their edges and at their extremities.

11. A. To ascertain whether there are found in the mountains sunk or petrified trees, at heights at which they would not grow at present; and to examine if it thence follows that there may have been a time when the upper strata of the atmosphere were warmer than they are at present.

12. Caverns: if there are any, their form and dimensions; the nature of their sides; the nature and inclination of their bottom; vestiges of the effects of the water by which they may have been formed; stalactites and incrustations, foreign bodies and bones which they may contain.

13. Whether there are found vestiges of large basins disposed in stories above each other, and which might have served as reservoirs to different seas that afterwards might have run off and united themselves in the basins of the present seas.

CHAP. X.

Observations to be made on the Strata of the Earth and Mountains.

1. The first question is to determine whether a mountain or any mass of earth and stone is or is not divided by strata*.

2. What, in regard to the theory of the earth, gives importance to the question, whether a mountain is or is not

* The word *stratum*, originally synonymous with that of *bed*, expressed the situation of a substance extended horizontally, and with an uniform thickness, on a plain and horizontal base. But the signification of this word has been enlarged, and it is now employed to express the situation of substances extended with an equal or almost equal thickness on bases which are neither plain nor horizontal. *Note of the Author.*

Might not the term *stratum* be reserved for those that are horizontal, and the name of *banks* be given to others? C.

Stratified, or composed of strata, is the supposition that stratified mountains have been formed by the successive deposition of substances before suspended in a fluid, while those which exhibit no signs of strata may be supposed to owe their origin to a simultaneous creation, or an accumulation not formed in a fluid, or which, at least, had nothing successive or regular, or in which there remain no traces of regularity.

3. If the mountain or mass exhibits no marks of division, the question of its being stratified or not is superfluous. We shall suppose then that it presents divisions, and require to know whether these divisions may be called *strata*. The solution of this question depends upon three considerations: viz. The regularity of these divisions, or their parallelism. Their number: the greater the number, the more it excludes the idea of fortuitous parallelism. The parallelism of these divisions with the laminæ or parts discernible in the inside of the mass.

4. Though the strata, in general, have the form of a parallelopipedon, some are seen cuneiform; in others are observed alternate swellings and constrictions; and others are seen ramified, dividing themselves sometimes into two or three, or two and three uniting and forming themselves into one.

5. Besides the form of the strata, to observe their extent, either in the same mountain, or in several mountains near each other, or even at a distance.

6. To observe also their inclination, or the angle which they form with a horizontal line, and the point of the horizon to which their declivity is directed.

This last observation determines the direction of their planes, or the two opposite points of the horizon through which their planes would pass, were they prolonged, after being made entirely straight. This direction of the planes is of importance to be considered, especially in vertical strata.

7. To examine whether this direction is parallel, oblique or transverse to the direction of the body itself of the mountain,

tain, the chain of which it makes a part, and the adjacent valleys.

8. To examine also whether the declivity of the strata is conformable to that of the external surface of the mountain; that is to say, whether they descend towards the outside of the mountain, or towards the interior part.

9. To examine next whether the inclination is the same from the bottom of the mountain to the summit, or whether it varies at different heights; whether it be the same or different at the opposite sides of the same mountain. Strata in the form of a fan *.

10. It is of importance to observe, in inclined or vertical strata, whether their thickness is not greater at their basis than at their summit.

11. To observe the joinings of the strata, and whether any substance different from that of the strata is placed between them, and what is the nature and thickness of this substance.

12. To observe whether the contiguous or corresponding joinings of these strata are smooth or unequal; whether there are observed in them any knots that exhibit traces of crystallisation or undulations proceeding in a certain direction.

13. In mountains consisting of strata different in their nature, or of different thickness, to observe whether their return is periodical, so that the same order recommences after a certain number or determined interval.

14. Whether, at the bottom of a mountain consisting of horizontal strata, there are not found mountains composed of vertical strata resting against the basis of that mountain.

15. In bent or circular strata, to observe in the elbows or points where the flexion is greatest, whether the strata are or are not broken.

16. When the strata have the form of a C, to observe whether at the back of the C there is not a vacuity, which proves that the upper part has been thrown above the under part.

* Voyages dans les Alpes. § 656 and 677.

17. To examine, in general, whether the strata exhibit traces of violent convulsions, which may have changed their primitive situation ; or, on the contrary, whether the whole, as well as the straightening of the strata, may be explained by simple sinking down*.

CHAP. XI.

Observations to be made on Fissures.

1. Their form, dimensions, breadth, extent, and direction.

2. Their situation ; measure of their inclination ; direction of that inclination in regard to the cardinal points, and in regard to the adjacent mountain and valleys.

4. To observe, above all, the direction of fissures in regard to that of the planes of the strata ; because fissures, as is presumed, being produced, in general, by the earth sinking down, and this sinking down being the effect of pressure, fissures have been originally vertical or nearly so ; and, on the other hand, because the strata having originally been horizontal or nearly so, the situation of fissures, in regard to the strata, and the direction of both in regard to the horizon, may give some idea of the situation which the strata had when the fissures were formed, and even of the changes of situation which the mountain afterwards experienced.

Thus, fissures perpendicular to the planes of the strata, indicate that these fissures were formed when the mountain was still in its primitive situation ; and if they are also perpendicular to the horizon, it proves that the mountain is still in the same situation : but if fissures perpendicular to the strata are inclined to the horizon, we may conclude that the mountain has changed its situation since these fissures were formed †.

* 18. To observe, whether, on approaching the high primitive mountains, the calcareous strata do not seem to have been reversed in a more violent manner. B.

† An explanation and application of these principles may be seen in my *Travels*, § 1048, 49, 50, and 1218.

5. When

5. When the fissures are filled with matter different from the body of the mountain, that matter is called a vein.

6. Lastly, one must examine, in both sides of the same fissure, whether the strata correspond at the same height, or whether the corresponding strata are lower on one side than on the other. The first case indicates that the fissure has been produced by mere bursting asunder; and the second proves, besides, a sinking down of the earth*.

[To be continued.]

VII. *Observations on the Winter Sleep of Animals and Plants.* By Professor FABRICIUS. From *Magazin für das neueste aus der Physik.* Vol. IX.

THE so called winter sleep is a very singular property of animals and plants; and though it occurs daily before our eyes, we are not able to explain the phenomena with which it is attended. In cold countries many animals, on the approach of winter, retire to their subterranean abodes, in which they bury themselves under the snow, where they remain five or six months without nourishment or motion; nay, almost without circulation of their blood, which flows only sluggishly and in the widest vessels. Their perspiration is almost imperceptible: but still they lose something by it; as they enter their winter quarters in very good condition, and are exceedingly thin when they return from them.

Some animals enjoy their winter sleep under the earth, and others concealed below the snow; some for the same purpose creep into the holes of rocks, and others below stones or the bark of trees. Some kinds, such as swallows and frogs, can pass the winter in marshes under the water. In this state many of those exposed to the severity of the

* To observe whether this sinking down has not always taken place on that side which looks towards the flat country. C.

open air are destroyed by the frost when it is violent; and even some of those which have buried themselves share the like fate.

Plants have their winter sleep also; for, during the period of winter, their sap flows towards the root, and the circulation of it, which is very slow, takes place only in the widest vessels. Were the expansion of the sap in winter as considerable as in summer, it would burst all the vessels on being frozen.

Several observers have endeavoured to prove that this singular circumstance is merely accidental; and, indeed, no difference is found in the internal organization of those animals which have winter sleep, and those which have not. It is very remarkable that this property belongs in general to animals of prey. As these have far stronger powers of digestion, and stronger digestive juices, it would appear that abstinence from food for several months would to them be hardly possible.

The bear, the bat and the hedge-hog have winter sleep; but the white bear has not. As the latter is secured from the cold by his long hair, he finds nourishment in the dead whales and seals which are cast on shore by the waves.

The earth worms have winter sleep; but aquatic worms very seldom. Insects, as well as their larvæ, have winter sleep. Butterflies may be often seen fluttering about in the warm days of spring, after having spent the whole winter in that condition. Amphibious animals have winter sleep, those which live merely in the ocean excepted.

Few birds, on the other hand, are exposed to this state. The greater part of these, on the approach of winter, retire to a milder climate where they can find more abundant nourishment.

In Iceland the sheep have winter sleep, because in that country they are suffered to range in perfect freedom. In the winter season therefore they may be seen buried under the snow and in the bushes, where it would be impossible for them to remain were they not in that condition.

VIII. *Experiments made to ascertain the Composition of the Swedish Stone Paper or Artificial Slate. By J. G. GEORGI. From the New Transactions of the Imperial Academy at Petersburg, Vol. IV.*

THE invention of Arfuid Faxé, confirmed by many experiments tried at Carlscrona, but not yet communicated to the public, for making a certain kind of artificial slate or stone paper, which may be procured at a small expence, and can be employed instead of common slate, was announced and highly extolled a few years ago in several of the public journals. This substance was said to have a great resemblance to milled or paste-board; to be of an iron-red, white, or yellow colour; to be very hard and stiff, but somewhat elastic; to be subject to no alteration even when immersed in cold water for several months, or when boiled for several hours; to be hardened by exposure to the air; to resist fire a long time, and to burn slowly, after having experienced a great degree of heat, but, when left to itself, to become soon extinguished.

It is evident, therefore, that this paper may be applied to various economical purposes, such as sheathing ships, which it would not only preserve from rottenness, but also from being destroyed by worms; for guarding from fire the cooking places in ships and powder magazines, and, lastly, for covering houses and wooden buildings. To this it may be added, that plates of this paper fixed on with brass nails, and done over at the joinings with cement, might be covered with some oil varnish in such a manner as to be altogether impenetrable to moisture. We are told also that a small building constructed of wood at Carlscrona, and cased over with stone paper, after being filled with combustibles and set on fire, resisted the effects of the flames and remained unhurt, and that the same experiment repeated at Berlin on a smaller building was attended with the same result. One great advantage of this stone-paper also is, that it is exceedingly

ingly light, and may in general be procured at a cheaper rate than any other materials for covering roofs, as a plate of it 23 inches in length and 14 inches in breadth costs at Carlscrona only two schellings Swedish.

An invention of such utility and importance ought therefore to excite the ingenious to attempt an imitation of it, in order that, if possible, it may be rendered more public. As soon as I obtained a specimen of it from Sweden, I made experiments to try whether I could not discover the method of making it. The fragment which I first examined was a line in thickness. It was light, easily broken, and possessed all the properties above enumerated. As the analysis by which M. Antic de Servin, at the request of M. Crell, endeavoured to illustrate the nature of this paper, did not appear to me satisfactory, I subjected part of the specimen sent me to a farther examination, leaving a third portion entire for the sake of comparison.

After this examination the red stone-paper appeared to me to consist of, 1. Martial-bole, which seemed to be equal to half its weight, and which, on account of the chalk perhaps, or calcareous earth with which it was mixed, produced a little effervescence with acids. Perhaps also there were some particles of another earth, the discovery of which would be of little importance to the object of this research. 2. A vegetable matter of little weight, and similar to that used in the making of common paper. This formed about a fourth part of the weight. 3. An animal glue, similar to that which is procured by boiling from various animal substances: and, 4. A certain oil which seemed to have a resemblance to linseed oil. These substances (3 and 4) made about a fourth part of the weight.

Another specimen which I received from Mr. Cameron, architect to her imperial majesty, contained the same substances in proportions a little different. I was, however, not able to obtain specimens of the white and yellow stone-paper,

in which M. Servin observed some traces of martial vitriol (*sulphat of iron*).

Though I made a number of experiments in order to discover the composition of this slate, I shall here mention those only which were attended with the best success. But, to avoid repetition, I shall first describe that previous manipulation which appeared most convenient.

The red or white bole, carpenter's ochre and chalk, which I employed for this use, were reduced to a fine powder. A pulpy mass of the coarsest kind, procured from a paper-manufactory, after being macerated in water, was strongly pressed and weighed out for use. The weight was increased about two-thirds by the moisture. In giving an account of the following experiments, I shall mention the weight of this substance as alluding to it when dry.

The glue was dissolved in a moderate quantity of water. I added martial vitriol undissolved, and employed unboiled linseed oil.

For want of a sufficient quantity of raw pulp, I procured, for some experiments, fragments of coarse old paper and book-binder's shavings, which, after being boiled for about three hours, were much tenderer than that brought from the paper manufactory. A pound of this when wet, after it had been pressed, exceeded that which was dry by about two-thirds.

The pulp procured from a paper manufactory being mixed in a mortar with the dissolved gluten, and being afterwards formed into a paste by the addition of the above earths and sulphat of iron, was well beat up in the mortar, and linseed oil then poured over it. The mass, being prepared in this manner, was spread out with a spatula above a sheet of coarse paper placed on a board furnished with a rim or border; another sheet of the same paper was then spread over it, and a second board was placed above all. The whole being then inverted, the board with the rim was taken off, and then the first

first sheet of paper. The compressed mass was then laid over upon another board sprinkled with sand, and left to dry, after taking the sheet of paper from its other side. Squares made in this manner dry without cracking; but as they become warped, it is necessary afterwards to flatten them, by putting them, with boards between, under a screw-press, and letting them stand for some time.

EXP. I. I mixed an ounce and a half of the dry pulp from the mill with two ounces of common glue, and, having added red bole and ochre, of each two ounces, obtained a smooth plate.

II. To two ounces of pulp I added four ounces of red bole pulverised, and half an ounce of chalk, with an ounce and a half of glue. The plate thus produced was full of wrinkles and chinks, but tolerably hard.

III. An ounce and a half of pulp, with four ounces of bole, and two of sulphat of iron, produced a plate equally hard, but uneven.

IV. An ounce of pulp procured from old paper and book-binder's shavings mixed, with half an ounce of glue, an ounce of powdered chalk, two of bole, and an ounce of linseed oil, produced two thin plates smooth and hard.

V. Two ounces of pulp from the mill, with half an ounce of glue, six ounces of red bole and two of chalk, to which were added two ounces of sulphat of iron, and the same quantity of linseed oil, afforded plates that were smooth, but not strong.

VI. An ounce and a half of pulp, with an ounce of glue, and four ounces of white bole, produced a plate smooth, beautiful, and hard.

VII. An ounce and a half of pulp, mixed with two ounces of glue, two ounces of white bole, and as much chalk, yielded a smooth plate as hard as bone.

VIII. An ounce of pulp, one ounce of glue, three ounces of white bole, and an ounce of linseed oil, produced a plate sufficiently perfect and elastic.

IX. A plate which I formed of an ounce of pulp, with half an ounce of glue, three ounces of white bole, an ounce of chalk, and an ounce and a half of linseed oil, was superior to that mentioned in the preceding experiment. This substance retains figures impressed upon it, and, tinged with half a dram of Prussian blue, assumed a blueish green colour.

X. An ounce and a half of pulp, with an ounce of glue and four ounces of chalk, afforded a plate exceedingly spongy.

XI. An ounce and a half of the same pulp, one ounce of sulphat of iron, and four ounces of white bole, without glue, produced a plate yellowish and spongy.

XII. An ounce and a half of pulp, four ounces of white bole, with an ounce of sulphat of iron, and the same quantity of glue, produced a yellowish plate a little more solid.

I tried several other mixtures; but as the plates they produced were of an inferior quality, I shall not give any account of them. The plates which had been prepared in the above manner I cut into several pieces, and daubed over a specimen of each with boiled linseed oil. The parts covered with the oil assumed a darker colour, and the superficies acquired more solidity, nor were they less capable of resisting fire.

Being desirous of comparing the productions of my experiments with specimens of the Swedish stone-paper, I macerated about an inch square of each in cold water. After they had been macerated four months, the specimens prepared with sulphat of iron were considerably swelled, but those made without linseed oil seemed to have scarcely swelled at all. Those, however, which I had daubed over with boiled linseed oil or linseed oil varnish, exhibited as little appearance of change as the Swedish.

I put a square inch of each of the different kinds upon an iron spatula, together with a like quantity of beech wood, and exposed the whole to a strong heat in the mouth of a furnace. After fifteen minutes the wood began to burn, and in fifteen minutes more was reduced to ashes. The fragments

fragments of the different specimens of the stone paper, exposed to the same heat, were in such a state of ignition that they hissed when immersed in water. I however examined them with great attention. The fragment of the Swedish manufacture was somewhat black on the surface, and puffed up into small blisters; but did not seem to have burnt, or to have changed its form. The specimens prepared with the sulphat, being more spongy at the edges, burnt; but so slowly, that in those of the worst quality the fourth part was scarcely consumed in the above time. All the rest, inferior in nothing to the Swedish specimen, resisted the fire with equal strength; so that most of them were only a little blackish on the surface, and entirely free from blisters; nor did there appear any difference that could be ascribed to the glue or linseed oil employed, as they were all of the same consistence, and none of them seemed to have been warped by the heat.

I then put some of the same fragments toasted in the fire on a red-hot plate of iron, and immediately exposed them for fifteen minutes to a strong heat in the middle of a furnace. The Swedish specimen burnt, and for five minutes emitted a thick smoke; then appeared of a white heat for some time, and at the end of fifteen minutes was converted into three friable cineritious laminæ. The specimen produced by my first experiment burnt in the course of a minute, kept up a flame for three minutes, and in fifteen minutes was converted into a black plate sufficiently hard. Specimens of the second, third and fourth experiments exhibited the same appearances. A plate produced by the fifth experiment was sooner destroyed by the fire, and appeared friable like the Swedish. A plate of the sixth experiment, which before had been scarcely changed by the fire, bore the last exposure exceedingly well; was scarcely changed in its form and magnitude, continued sufficiently hard, and was only rendered black and as it were scorched. A specimen of the seventh experiment burnt for a whole minute, and became

black and friable like the preceding. A specimen of the eighth burnt for two minutes, and then continued black and sufficiently hard. The same was the case almost with the ninth specimen. A specimen of the tenth, though it became black, was however scarcely changed. A fragment of the eleventh experiment burnt with a flame for about two minutes, and was converted into ashes; which was the case also with the specimen produced by the twelfth experiment.

Those specimens produced by my fourth, sixth, seventh, eighth and ninth experiments, seemed to be the best in their external qualities and their power of withstanding fire and water. The same fragments suffered as little from the influence of the weather and atmosphere as the Swedish. The materials for making this article may be readily procured for a small price; and the process is simple, and requires very little time. My specimens indeed were not so neat and elegant as the Swedish; but this inferiority may be obviated by practice and experience: and even in its imperfect state the invention may be of great economical utility.

The cement which the Swedes recommend for filling up the interstices between the squares, and of which I received a specimen from Mr. Cameron, was composed of linseed oil varnish, white lead and chalk, mixed together in such a manner as to approach to a fluid state, that it might more easily insinuate itself into the fissures.

As the chief use of this invention is to cover and incrust houses, I was desirous of trying my production by exposing it to the effects of the weather. I therefore nailed fragments of the Swedish stone paper, and of that made by myself, to a small board; and having daubed over the joinings with cement, I exposed them in the month of August on the top of my house, and in the beginning of April the next year I found they had undergone no change.

IX. *On the so called Sea Froth and other Substances of which the Bowls of the Turkish Pipes are made. From a Letter written in Persia by Dr. REINEGG, Correspondent of the Royal Society at Gottingen, to BARON VON ASCH at Petersburg. Communicated to the Society by Professor BLUMENBACH.*

THE so called sea-froth (*litbomarga*), of which the bowls of the Turkish pipes are made, is not an artificial composition, but a natural kind of earth dug up near Konie in Natolia. This place, the ancient Iconium, lies in a most fruitful district, which may be truly called a terrestrial paradise; and is celebrated on account of a large monastery of Dervises founded by the Scheik Abid il Daher, but which received particular endowments from Sultan Suleiman, and in which at present there are two hundred Dervises under the direction of a Scheik, by whom they are clothed and maintained.

The income of this monastery arises in part from some natural productions of that district, such as marble, &c. and in particular from the above-mentioned yellowish white earth, of which the bowls of the Turkish pipes are made. It is dug up at Kiltfchik, (that is, the place of clay,) a village five miles distant from Konie; and besides this I have heard of no other place, either in Natolia or along the coast of the Mediterranean sea, where any of the like kind is produced. It is found in a large fissure six feet wide, in grey calcareous earth; and the workmen assert that the earth grows again in the fissure, and puffs itself up like froth. They therefore call it *kill-keffi*, or *kill-kefi*, a word which, if I read with Tefchdid, *kill-keffi*, signifies clay-froth, or light clay.

This earth, when it comes from the fissure, is heavy, soft and greasy. It sweats if thrown into the fire; produces a fetid vapour; grows hard, and becomes perfectly white. The fresh earth dissolves in no acid. That which has been

burnt can be acted upon only by the nitrous acid; but not until the solution has been continued a considerable time in heat, and then it loses nearly a third of its weight. When water is poured on the pure solution, it becomes a little muddy; and when it is suffered to evaporate entirely, a bitter salt exceedingly easy to be dissolved is obtained. The undissolved earth, fused in a strong fire, is converted into a brown slag. The fresh earth remains in water unchanged; and when it has been mixed with it by shaking and stirring, it falls again to the bottom, loses its cohesion, and cannot be again used. The earth, after being burnt; imbibes a large quantity of water, throws out abundance of air bubbles, and becomes soft.

The peasants of the village of Kiltichik dig up a sufficient quantity of this earth, for which they pay a certain sum to the monastery, and then cut it into bowls for tobacco pipes. For the most part, however, they press the earth, while yet soft, into proper moulds in which the figures of various flowers have been cut; and while the bowls are in these moulds they bore the holes in them, and then lay the bowls in the sun to dry. Some days after, when the surface of them is covered with a hard yellowish crust, they place the whole quantity of bowls in a heated baker's oven, and let them remain there till it is entirely cooled. They then boil them for an hour in milk; and when they are taken from it, they rub them with *Bisbik Kuirugbi* (*equisetum*) common horse tail, in order to make them smooth and shining, which is at length completely effected by means of a piece of soft leather.

When the bowls have been prepared in this manner, and sent to Constantinople for sale, they are dyed there of different colours, partly by being boiled in wax or oil. The best mixture, however, is dragon's blood and nut-oil; for when the bowls have been well soaked in this mixture and penetrated by it, they acquire, in a short time, a most beautiful dark-red dye. The Turks, however, in general are
not

not very fond of tobacco pipes made of sea-froth: and they are seldom used by the Asiatics; for they are too heavy, hold too much tobacco, and in some measure lessen the agreeableness of its taste. The Turks, therefore, prefer pipe-bowls made of red clay, and sell the former chiefly to the Greeks, who transport them to Transilvania and Hungary.

These small red pipe bowls are, on the other hand, in common use throughout all Lesser Asia, Arabia, Egypt, &c. and are formed of a real kind of clay-earth; but in places where that clay-earth is not to be found, they are imitated by some artificial composition, which is indeed preferable; for those burnt of clay have in general a pale red colour, whereas those made artificially have a beautiful high colour. The earth of which these bowls are made is not a red bolus, but a blueish argillaceous species of potter's earth. Such, at least, were those which I saw at Trebifond, Poli, and Cæsarea, where an immense number of these pipe-bowls are made.

In those places, on the other hand, where this species of potter's earth cannot easily be procured, or is not valued, as at Constantinople and Tocat, the pipe-bowls are prepared in the following manner:—Small fragments of thoroughly burnt tiles, particularly old ones, are pounded and then reduced to fine powder in a mill. Three parts of this tile-dust are then mixed with one part of any well washed argillaceous earth in pits made for the purpose, or in wooden boxes, and water to the height of a few inches is poured over it. This mass is daily stirred during a week; the water is poured off and fresh water poured on every evening; at the end of the week the whole paste is well stirred round with sticks, and when the useless coarse sandy parts begin to sink to the bottom, the remaining muddy water is drained off into other vessels, where it is suffered to remain till the argillaceous paste falls to the bottom and the water has again become clear. The remaining water is then carefully drained off, and the clayey cake, as it dries, is well kneaded. As soon as it is so dry as

to be fit for being worked, it is mixed with a somewhat less quantity of umber, and formed into pipe-bowls, either in a mould, or by being applied to the lath.

When these bowls have been sufficiently burnt, they acquire a dark brown colour, which, however, changes into a beautiful red as soon as they have been well rubbed with a piece of leather sprinkled over with fine pulverised blood-stone (*hematites*). Owing to this simple process we obtain from the East those red pipe-bowls, so much and so generally esteemed, at a very low price, as five of them are generally sold for a para *. When they are ornamented, however, with a gilt border, painted with golden flowers, enamelled or set with precious stones, one of them will cost sometimes two, three, and even four piastrès †.

X. *A singular Phenomenon respecting Snow, some of which of a red Colour was found on the Alps.* By M. DE SAUSSURE. From *Voyages dans les Alpes*. Vol. III.

WHEN M. de Saussure explored mount Breven, for the first time, in the year 1760, he found in several places on a declivity snow still remaining, and was not a little surprised to see the surface of it, in various parts, tinged with a very lively red colour. This colour was brightest in the middle of such spots as had their centres more depressed than the edges, or where different planes covered with snow seemed to be joined to each other. When he examined this snow more closely, he remarked that its redness proceeded from a very fine powder mixed with it, and which had penetrated to the depth of two or three inches, but no farther. It did not appear that this powder had come from the higher parts of the mountain, because some of it was found in places at a considerable distance from the rocks and much

* The value of a para is about three farthings.

† A piastrè is equal to about half-a-crown.

lower down; and it appeared also that it had not been conveyed thither by the winds, because it was not disposed in stripes or in the form of radii. The most probable conjecture therefore was, that it was a production of the snow itself, or the remains of its partial melting suspended at its surface as in a filtre when the water passed through it. What seemed to favour this conjecture still more, was, that the colour at the edges of the hollow places where little water had sunk down was extremely faint; and, on the other hand, shewed itself stronger in those parts where the greatest quantity of water seemed to have penetrated.

M. de Sauffure took a tumbler full of this snow, as he had no other vessel with him, and held it in his hand till the snow melted, when he soon saw the red dust deposit itself at the bottom. Its colour then did not appear so dazzling as before, and when dry it lost it entirely: it decreased also in quantity, so as almost to appear nothing.

Next year M. de Sauffure ascended the Breven, and found on it a quantity of the same kind of red snow, some of which he squeezed closely together and put into a large handkerchief, but before he got home it was entirely dissolved by the heat of the sun. It was not, however, on the Breven alone that he discovered snow of this kind; for he found of it on all the high mountains of the Alps, about the same season of the year, and in similar situations; so that he was much surprised that authors who had written respecting the Alps, such as Scheuchzer, had made no mention of it. It is, indeed, true that it is found only in hollows, where the snow lies deep, and at a season of the year when the melting of it has proceeded to a certain degree; for, when none of the snow or when very little of it has been melted, the dust is then in too small quantity to attract the eye; and if the melting has proceeded too far, the whole of the powder has passed through with the water, and it becomes equally invisible. Besides, towards the end of the melting, a great many foreign particles and impurities, conveyed thither by

the wind, are mixed with it, so that its colour is no longer distinguishable.

In the year 1778, when M. de Saussure was on mount St. Bernard, he found a great deal of the same kind of snow. He collected as much of it as he possibly could; and Mr. Murrith, an experienced naturalist, collected of it also; so that they were enabled to make some experiments. On account of its great specific gravity, M. de Saussure treated this red powder as an earth, first with distilled vinegar, but he employed so little that he had no result. He then boiled it in the muriatic acid, and obtained a solution, which, when carefully distilled and filtered, had so brown a colour that he was quite at a loss respecting the nature of this substance. He therefore applied it to the blow-pipe, and observed that it inflamed with a smell like that of burnt vegetables.

This experiment induced M. de Saussure to digest 40 grains of the powder in spirit of wine; and having filtered the solution, he found that the residue weighed 7 grains less: the spirit of wine had become of a golden yellow colour. He then distilled it in a *balneum mariæ*, and the spirit of wine came off perfectly pure. An oily transparent matter of a golden brown colour, which by the warmth of the *balneum mariæ* had not become dry, remained at the bottom of the retort. This oily matter had a smell like that of wax, which it emitted also when burning. The deposit, which the spirit of wine had not dissolved, was, in regard to its extractive part, also inflammable; and the ashes which remained after it was burnt, though they did not seem alkaline, were fused by the blow-pipe into a porous kind of greenish glass.

These experiments seem to prove that this powder was a vegetable substance, and probably the farina of some flower. M. de Saussure was acquainted with no plant in Switzerland that produced red farina in such abundance as to tinge the snow of the Alps red; especially when it is considered that a great deal of it must be lost before it can reach the spots
where

where the red snow is found. But the action of light, perhaps, may first give it its red colour; and in regard to its specific gravity, that is not surprising, as by its long continuance on the snow it must, on account of the repeated snow meltings, receive such an accumulation of particles as to become dense and heavy.

M. de Sauffure communicated his discovery to M. Bonnet, who advised him to examine the powder with a microscope, in order to see whether it exhibited the appearance of the farina of flowers. He did so with the greatest care and the best glasses, but he could not discover the least regularity in its form.

Though M. de Sauffure found this powder in different places on the Alps, he however asks, whether it be very common, and whether it be found on the high mountains in different countries and different climates, such, for example, as the Cordilleras? These questions deserve certainly to be examined; and though it be probable that this powder consists of the farina of flowers, it is not altogether impossible that it may be an earth separated by the snow itself, and possessing some inflammable properties called forth by the immediate action of the light and heat of the sun, which shines with so much liveliness in the pure air of these elevated regions.

XI. *Description of an Apparatus proposed to be applied to M. KLINGERT'S Diving Machine, to enable it to be used at greater Depths than it otherwise could.*

SOME doubts having occurred to the inventor of the diving machine, described in our last Number, respecting the practicability of employing it at very considerable depths, he was induced to propose an additional apparatus to render it more extensively useful. The description of this proposed improvement we shall give in his own words: "Supposing it

it possible," says he, "to proceed to the greatest depths with the before-described machine, difficulties may still arise on account of the great length of the pipe; for it may be asked, Can the diver breathe long when the column of air is of such a length? I have found that it is difficult to breathe long through a pipe of a hundred feet, and half an inch in diameter; that the breast soon becomes fatigued; and that it is much easier to breathe through a pipe of half that length. Though a greater diameter may in part obviate this difficulty, so that the diver can breathe with more ease, yet another question arises: At the depth of a hundred feet and more, is it possible for the diver to manage such a long tube conveniently, as it must meet with resistance according to particular circumstances, and as by its length it must acquire considerable weight? How would he manage when he wished to rise again to the surface? and at such a depth could he make a signal for that purpose, and with sufficient quickness? On account of these questions I turned my thoughts to another machine, to be used in necessary cases with the former, and I hope the one I mean to propose will be found worthy of some notice.

"The figure (Plate III.) represents the machine, which consists of a hollow cylinder, terminating in two hollow truncated cones. It is constructed in the same manner as casks, and made exceedingly strong. In order that the wood may be rendered water-tight, it is daubed over on the outside with any proper varnish or cement.

"By means of the interior construction of this machine a man can descend to a great depth in the water, and live and move freely without a pipe to supply him with atmospheric air, because, being placed on a stage without the machine, and furnished with a harness and pipe like that before described, he can obtain air from the space within it, which contains 58 cubic feet. He may, therefore, remain under water two hours; descend from the stage at pleasure, move about with freedom, and, by means of the machinery within,

within, rise and descend when he thinks proper, as will appear from what follows :

“ Those who have made experiments with air will not doubt that 50 cubic feet of it are sufficient to maintain the life of a man for two hours ; and the possibility of ascending and descending at pleasure may be thus explained :

“ As this machine contains such a volume of air that it is lighter than water, it will require a considerable weight to make it sink below the surface. That as little, however, as possible of the space destined for containing air may be lost, lead may be employed, in the inside of the machine at *b*, sufficient to make it sink so far that a cubic foot of it only shall remain above the surface of the water. An additional weight then of 100 pounds will not only depress it below the surface of the water, but make it sink even to the bottom.

“ But the same thing may be effected without weights, by lessening the volume of the contained air. This is done by means of the piston *c*, which fits closely into the cylinder *d*, and which, by means of the rack *e*, the pinion *f*, the wheel *g*, and the endless screw *h*, together with the winch *i*, can be moved either upwards or downwards.

“ The machine, however, must not only be strong and durable, but be constructed according to the depth to which it is destined to descend and the pressure on the piston, that a man at such a depth may have sufficient strength to depress it by means of the winch, and thereby to enlarge again the volume of air. It will readily appear that, by raising the piston, the machine must sink to the bottom ; and that, by depressing it, the machine must again ascend ; as was proved by a small model which I made for that purpose.

“ If a machine be constructed on a large scale, according to the proportions exhibited in the annexed figure, it will be found, by calculation, that, if we estimate the friction of the piston, when made water-tight, at 200 pounds, and that of the wheel-work at 300, though it may perhaps not be so much, the winch at the depth of 120 feet will not require a
force

force of 40 pounds. If the diameter of the piston, however, be lessened, and the cylinder, in order that it may have the same cubic content, be lengthened, and if a larger wheel be added to gain more power, something will be lost in regard to time; but it can be easily calculated to what greater depth the machine may be used, and how much the strength of a man can accomplish. The higher the machine is in proportion to its diameter, the more securely will it remain perpendicular in the water, and the less danger will there be of its being overturned; because the diver is then nearer the centre of gravity. That the same advantage, however, may be obtained with less expence, the wheel work, together with the cylinder and piston, may be omitted, and the machine constructed as far as the upper cover *o*; but it must be so furnished with hooks for ballast, that the diver, when he has previously screwed on the pipe fastened to the machine and placed himself on the stage, may hang on ballast, stones or other heavy substances, till it sink, and, by throwing them away, may again ascend at pleasure. The machine in this form is simpler; and, in my opinion, to be preferred to the construction with the piston, wheel and rack, which I shall endeavour to prove in as mechanical a manner as possible.

“ The ends of the pipe *lm*, which proceed into the machine, are so applied that all the particles of air may gradually proceed through the lungs. Should it, however, after being used two hours, be no longer capable of supporting life, the diver must ascend with his machine, and be conveyed to the ship or boat attending him, by means of the rope fastened to the ring *n*. He must then screw off the pipe, open the top *o*, and, by means of a pair of bellows screwed upon the mouth-piece, expel the air from the machine, and blow into it sound atmospheric air for further use*.

* This is not an effectual way of removing the tainted air, which may be more simply, and at the same time completely effected, by immersing it, when open, under water: on the pouring out of which afterwards, the machine would be filled with atmospheric air. EDIT.

“ Two

Two small oars may be added to the step or seat in order to make a few movements, and also an anchor or grapnel to fasten the machine to the bottom, that the diver may be enabled to walk about with the pipe at freedom, for the purpose of examining sunk bodies, and discovering the properest method of raising them. For the greater security, in case any accident should happen to the machine, an apparatus may be applied to the pipe, that the diver can leave the machine and rise without it; which he might easily effect, by throwing away the weights suspended from his harness, and by retaining between his body and harness a sufficiency of air for ascending. By these means he might leave the great machine, even if he were not acquainted with swimming. As soon as he rose to the surface, he would obtain fresh vital air through the opening *g*. (*See Plate I. of the preceding Number.*)

“At *p* is a lantern, the use of which is to afford the diver light in the water; because the solar light is prevented from penetrating to very great depths by the many foreign small particles mixed with that fluid, and is therefore incapable of rendering bodies lying at the bottom of it visible; and because occasions may occur when artificial light will be necessary.

“I have also prepared such lanterns to be held in the hand; but, for particular reasons, I must here abstain from explaining their construction, and only assure the public, on my veracity as an honest man, that they answer the intended purpose. A candle in these machines, which are very simple, will burn in every kind of air, in mines and pits, where all other lights are extinguished. They contain a space equal to a cubic foot; and the candle burns, without any new addition from without, for two or three hours: they endure all concussions of the air, and are deranged by no motion or working in mines. Their utility, therefore, in other respects may readily be conceived. I shall not fail, however, at another time, to make them publicly known, as well as all the previous circumstances which led me to the discovery.

XII. *Singular Instance of the Attachment of Birds of Prey to their Young.* By M. CRONSTEDT. From New Transactions of the Royal Academy of Sciences at Stockholm, Vol. X.

MR. Cronstedt resided several years on a farm in Sudermania, near a steep mountain, on the summit of which two eagle-owls (*strix bubo* L) had their nest. One day, in the month of July, one of the young owls having quitted the nest was caught by some of his servants. This bird, considering the season of the year, was well feathered; but the down appeared here and there between those feathers which had not yet attained their full growth. After it was caught, it was shut up in a large hen-coop, and next morning M. Cronstedt found a young partridge lying dead before the door of the coop. He immediately concluded that this provision had been brought thither by the old owls, which no doubt had been making search in the night-time for the lost young one, and might have been led to the place of its confinement by its cry. This turned out to have been actually the case; for M. Cronstedt found that the same mark of attention was repeated every night for fourteen days. The game which the old ones carried to it consisted chiefly of young partridges, for the most part newly killed, but sometimes a little spoiled. One time a moor-fowl was brought to the young owl, so fresh that it was still warm under the wings: a putrid stinking lamb was also brought. M. Cronstedt supposes that the spoiled flesh had already lain a long time in the nest of the old owls, and that they brought it merely because they had no better provision at the time. He and his servant tried to watch several nights, in order that they might observe through a window when this supply was deposited; but their plan did not succeed, and it would appear that these owls, which are very sharp-sighted, had discovered the moment when the window was not watched, as food was found to have been deposited for the young before the

the coop that very night. In the month of August this care ceased ; but that period is exactly the time when all birds of prey abandon their young to their own exertions. It may be readily concluded, from this instance, how much game must be destroyed by a pair of these owls during the time that they rear their young. This observation is applicable to the whole race of owls, in general ; and these may be considered therefore as the most destructive of all the birds of prey. As the eatable-birds of the forest repair chiefly in the night-time to the fields, they are particularly exposed to the acute sight, smell, and claws of these birds of the night ; and even the swift-footed hare seldom escapes them.

XIII. *A short View of the Mitchillian Theory of Fever, and of Contagious Diseases in general.*

CERTAIN exhalations from marshes and swamps, and from collections of putrefying vegetable and animal substances, induce diseases attended with different degrees of malignity, according to circumstances. There is a great similarity at least in the diseases induced by the exhalations from marshes and from putrefying substances: it ought to be so ; for the noxious quality of the former is in consequence of their containing the latter ; and hence such diseases, though improperly, have been called putrid.

What is the peculiar substance, or what the substances in these exhalations that cause what are termed contagious diseases ? What the mode of action ? Animal and many vegetable substances, especially those which contain gluten, give similar products when decomposed by the putrefactive process.

Can hydrogen gas be the deleterious product ? No—its base combined with different substances makes a great part of our aliment ; with carbon it forms fat—with oxygen,

water—with azote, the volatile alkali (ammonia), used as a medicine.

Carbonic acid gas cannot possess a contagious quality, for it is continually generating where its effects would be most hurtful—in the lungs, from whence it is constantly emitted by expiration. We swallow it in great quantities in beer and other fermented liquors; and, combined with hydrogen gas, it may, as has been proved by the English pneumatic physicians, be taken in large doses as a remedy for different diseases.

Azotic gas forms nearly two thirds of the common atmosphere we breathe: its base united to other substances composes a great portion of our food. Oxygen gas forms the other third.—without it we cannot live.

Such gases therefore may be *mixed* with each other, and yet not be the cause of contagion. Where then is it to be sought? In some *chemical union* between two or more of them, or their bases, effected, by the operation of some cause, during their separation from the organised body of which they formed a part, by the process of putrefaction.

Permanently-elastic fluids owe their gaseous form to a chemical union of caloric with their respective bases. When this union is once effected, two gases may be mixed or blended together, as oil with water, or wheat with barley; but no chemical union can be effected between them, the attraction of the base of each for caloric being stronger than that of the gases for each other. When the affinity of their bases for each other is stronger than for caloric, a chemical union of the bases may take place; but in that case the caloric is set at liberty, and the product, instead of being gaseous, is concrete, as when ammoniacal gas is presented to carbonic acid gas.

But if the bases act on each other before either be saturated with caloric, a chemical union may be effected between them: thus azote and oxygen will yield the nitrous acid.

acid. If caloric, as a third principle, unite itself, so as to saturate the oxygen and azote at the moment of their extrication, not to each respectively, but as entering chemically into union with each other, the result will be a gas holding the three ingredients chemically united, and consequently possessing very different properties from a mixture of oxygen gas with azotic gas; for, in the latter case, the base of each having been previously saturated with caloric, both the gases by that means have been put into a state that prevents the possibility of a chemical union taking place between them.

When a *mere mixture* of oxygen gas and azotic gas (atmospheric air) is inhaled into the lungs, the animal powers exert such an action on the oxygen gas as to effect a separation between the oxygen and caloric, applying each to the purposes intended by nature; while the greater part of the azotic gas is respired undecomposed, mixed with the carbonic acid gas that has been generated by the union of a portion of the oxygen gas with carbon furnished by the animal, and with moisture formed by a portion of the base of the oxygen gas with hydrogen, the caloric of that portion having gone to the supply of the animal heat. But if a gas composed of oxygen and azote *chemically combined* with each other and with caloric, be diffused through the atmosphere inhaled, a substance is received into the lungs possessing very different chemical properties from common air; for, though the component principles be the same, being combined in a very different manner, it must possess a very different mode of action upon the animal. In fact, it may be taken into the system in its combined state, where, meeting with principles which possess a stronger affinity for some of its constituent parts than they do for each other, it may be decomposed; while, by the same operation, the animal fluids, or solids, or both, are themselves decomposed, by parting with one or more of their principles which enter into the new combination.

Where such a noxious gas abounds, it is no wonder that pestilential disease should be the consequence, especially if it should prove miscible in water, for then it will be taken in with the food and drink, and may even be absorbed by the skin, as well as by the nose, palate and lungs.

The nitric acid, which is composed of oxygen and azote, possesses very different properties from atmospheric air, which is a mixture of these two each previously combined with caloric. It would be just as fair reasoning to say that, their bases being the same, they must possess the same properties, as to infer that the noxious gas above mentioned should possess the same properties with atmospheric air, because composed of the same ingredients.

Oxygen and azote, by certain operations of nature, enter into combination with other elements to form organised bodies. By this process they are put into a situation which enables them to form a new union as soon as the laws by which the organised structure maintains the harmony of the complex combination, cease to exert their influence upon it. New affinities then begin to operate, and that species of decomposition so well known by the name of putrefaction is the immediate consequence. The oxygen and azote, during their extrication from the putrefying substance, may come within the spheres of each other's attraction, without entering into an intermediate state of gas by union with caloric: and in this way it is probable some modification of nitrous gas, or the nitrous acid, is formed, according as caloric enters or not as a third ingredient into the compound.

As this gas, which the supporters of the present theory consider as the matter of contagion, according to them, always owes its origin to the putrefaction of animal and vegetable substances, they have given it a name expressive of that origin. They assume the word *septon* to express the radical of the nitrous acid, and derive it from $\sigma\eta\pi\omega$, *putrefacio*; whence comes *septon*, *putridum*; and propose that the combinations

formed from the base of the nitrous acid may have new terms in the nomenclature, and be arranged in the following order :

Septon, for azote or nitrogen

Septous gas, for azotic gas

Gaseous oxyd of septon, for dephlogisticated nitrous air*

Septic gas, for nitrous gas

Septous acid, for nitrous acid

Septic acid, for nitric acid

Septat, septite—for nitrat, nitrite, &c.

By insisting that the nitrous acid is of animal derivation, or from vegetables possessing the same principles, the Mitchellians only mean, that nature effects the decomposition of azotic gas by the operation of those laws which she employs in forming organised bodies ; that oxygen (not in combination with caloric) enters into the composition, and that during the destruction of such bodies these principles unite with each other. By the affinity the product has for the vegetable alkali, which, or the principles that form it, is extricated from decaying vegetables, it joins it wherever it can find it, and produces nitre, the grand source from whence the nitrous acid is made.

To prove this position, the works of those who have wrote on the production of nitre, and the nature of the soils where it is produced in the greatest abundance, are examined, and from them the fact is endeavoured to be established, that the putrefaction of organised substances is an indispensable requisite. Another fact is pointed out from the same source, and from medical writers, namely, that the neighbourhood of such soils is extremely unhealthy, especially at particular seasons of the year, when circumstances, in the first place, are such as to favour quick putrefaction, and in the second, to present the greatest number of obstacles to the septic (nitrous) gas, being taken out of circulation by being neutralised.

* So named by Dr. Priestley, because it can maintain combustion.

If such be the fact, it offers a solution of the question, Whence jails, hospitals, ships, and other crowded places, become infected with noxious vapours?—The animal exhalations, excretions, &c. go through the putrefactive process in the same way that dead animal substances would, and the products are the same. One of them, the gaseous oxyd of septon, being miscible in water, lodges itself in the damp walls, where, after it has saturated such of the substances it meets with as have affinity for it, it keeps accumulating, till some circumstance, as hot weather for instance, drives it out with the evaporating moisture, in such quantity as to infect the atmosphere.

That combination of septon (azote) with the acidifying principle which produces the gaseous oxyd of septon, is not however considered as exclusively the only proportion of the ingredients that produce contagion. There are an infinity of gradations in the proportions in which these principles may be united, and yield a contagious fluid—the vapours of the nitric acid itself are not excepted. These pestilential fluids are considered as being always, even in their weakest form, somewhat of stimulants. In many instances most violently so. Though their operation is modified, when in a dilute form they impede respiration, or nauseate the stomach, as they then bring on a diminution of action and energy amounting in the cold stage to a state of direct debility: when applied in great quantity and force, they kill instantly; when in less quantity, they produce an anomalous disease, of the form of which Chisholm's cases present instances; when in a weaker state, a common contagious catarrhal affection may be the consequence; when inhaled in a form yet more diluted, a remitting or intermitting fever may be the disease induced, of the form of quotidian, tertian, or quartan, or any of their varieties; or the remitting may be called jail, hospital, ship, camp, army, yellow, putrid, or bilious, malignant, pestilential, miliary, petechial, ardent,

flow, continued, continual, dysenteric, contagious or infectious, according to the circumstances that may occur in the progress of the disease.

“ The main difficulty left is to account for the cold fit of a regular tertian. This stage of fever I believe to depend upon impeded respiration, and the impeded respiration to depend upon the vitiated quality of the air taken into the lungs; or in some slighter cases, where the stomach is originally thrown into a disordered state, the lungs, by association with that organ, are thrown into disorder too, and for a time perform their functions but imperfectly.

“ Thus I presume it is that the impeded state of respiration is attended with a smaller evolution of heat and oxygen in the lungs, and consequently with more or less diminution in the circulation of the blood, and a proportionable degree of chilliness and coldness throughout the body. The duration and degree of the cold fit will correspond to the continuance and power of the causes disturbing the pulmonic organs, either by acting upon them directly or indirectly through the intermedium of the stomach.

“ From the small quantity of heat and oxygen communicated to the blood in the lungs, and the consequent slow and feeble circulation of the blood, can the shrinking, paleness, tremors, coldness, debility, &c. &c. be sufficiently explained, as the constitution is now deprived of its two chief stimulants.

“ But why does not the continued operation of the vitiated air upon the lungs, or the associated condition of the lungs with the stomach, go on in an increasing series even unto death? The power of our constitutions to become familiarised to the action of noxious causes, is evinced by the innocent operation of poisonous substances, which, by frequent repetition, grow gradually habitual, and by custom lose their primary operation. This disposition to become familiarised to vitiated airs, is apparent in the inhabitants of Africa, who are so seasoned to the air and climate they live

in, that it excites no disturbance at all in their constitutions, while strangers fall victims in the greatest abundance. Now, common intermitting paroxysms are instances of temporary seasonings, which the constitution experiences, of a kind quite analogous to what is perpetual with the Guinea negroes.

“The cold fit sometimes does terminate in death; and this happens when the constitution cannot acquire the habit of enduring the noxious cause with impunity. In the generality of cases, however, the stimulus of the infectious gas loses its power to operate before the constitution is debilitated to death; and as soon as it becomes, for this time, so much accustomed to the vitiated air, as no longer to be disturbed by its presence, the cold fit ends. The length and violence of the cold fit will thus be, *cæteris paribus*, in a compound ratio of the impediment given to the respiration by the infectious gas, and the facility with which the constitution accommodates itself to its action: if three persons then inhabit one house, it is possible that one may become so quickly accustomed to the air as to have no distemper; a second may have a moderate disease of but a few fits; while the third, possessed of a constitution not easily moulded to a new habit, may be incommoded by a violent and obstinate malady.

“In every paroxysm of an intermittent, the infection thus wears itself out; but this is only a temporary reconciliation of the body to its action; when, after a repetition of fits, the disorder becomes milder and milder, and after a while wholly ceases. This is a case of lasting reconciliation; and in this way may a large portion of small intermittents cure themselves, while the credit is given to the bark! This power of habit daily does wonders, and labours more effectually for the good of the sick than bark, opium and antimony put together.

“The attack of these causes being thus for a time overcome, respiration grows free, full, and frequent; because
there

there is now a greater appetency in the constitution for heat; more vital air is decomposed in the lungs; and more stimulus is applied, by means of the increased heat and oxygen now in the blood, to the heart and arteries: these stimuli operate more powerfully on account of the accumulated excitability of the body; and a degree of excitement is thence induced, which sometimes ends in death, sometimes causes delirium, and in almost every case exceeds the healthy temperature.

“The duration and violence of the hot stage will be, *cæteris paribus*, in a compound ratio of the excitability accumulated in the cold stage, and the heat and oxygen evolved in the hot one. When the excitability is exhausted by the operation of the stimuli, the violence of action will cease, and the body grow cool.

“The doctrine of intermitting fever, then, is briefly this: the vitiated atmospheric fluid, by interfering with the pulmonary action, brings on the cold stage, and would continue the same until its termination in death, did not the constitution in the mean time acquire such a habit as to gain a temporary insensibility to its action. This habit being induced, the cold stage abates by reason of the state of direct debility into which the body had been brought; anxiety continues, and, by the quickening of respiration, heat and oxygen are set loose in the lungs, and becoming incorporated with the blood, now warm and stimulate every part with more than usual power, and occasion the phenomena of the hot stage, which terminates as soon as the accumulated excitability of the system is exhausted.—The sweating stage follows of course, as in other cases of the subsidence of violent action: for, after a time, the exhausted excitability of the animal system allows excessive action to go on no longer; the respiration grows more moderate and easy; the heart beats with less frequency and force; the arterial contractions are also more slow and health-like; and, as the arterial contractions relax, the hydrogen and oxygen of the
blood

blood now run together in the extreme vessels of the skin, and form the moisture which bedews the surface; and this afterwards flying off by evaporation, cools by degrees the whole body down to its ordinary temperature: and, as the arterial extremities of the rest of the body become dilated by the subsidence of excitement, the other secretions, which had been generally suspended during the fit, now return as before: after this, the constitution, so far accustomed to the breathing such an atmosphere, regains its former vigour and functions, as far as the exercise induced and functions injured during the several stages will allow.

“The interval between one fit and the succeeding one, will be proportionate to the duration of the habit of resistance acquired. Some persons thus experience but one fit, and all is over; for, under the same circumstances they are never invaded by a second. Others suffer two fits, or a succession of fits, and after a while become so accustomed to the stimulus, that, if always applied in the same degree of strength, its effect is no longer felt upon the body: in other instances again, so hard is it for the constitution to be moulded into a settled habit of opposition, that after enduring a great number of invasions, it becomes at length enervated and worn down so much as finally to die exhausted.

“The species of fever, whether quotidian, tertian, &c. will depend upon the readiness or quickness wherewith the offending cause gains a new ascendancy over the body, or breaks the habit. And to the mobility of the body, or ease with which the habit is broken, is to be ascribed, as well the frequency of the returns, as the duration and severity of the paroxysms.

“The anomalous cases of fever, which have puzzled physicians to explain, and nosologists to arrange, are thus very naturally accounted for; since, according to the variation of the cause, as the noxious atmosphere may thicken or disperse, will be the variety in the effect produced; and as there may

be infinite gradations of the deleterious cause, there may be endless varieties in the morbid effect.

“ And to this principle of the human constitution, I believe, may be referred all the febrile ailments from the most trifling intermittent to the more serious remittent, and the solemn form of continued fever.

“ Hence further may it be understood how a succession of fits, long continued, may dispose the constitution to a repetition of fits, even when the morbid cause is away: for though there may be a habit of insensibility produced to the vitiated airs, yet a habit may, in the mean while, be established in the bodily motions of falling periodically into regular trains of action, even when the original cause is withheld. Here then will be produced a habit of having paroxysms depending on the particular inward state of the moving fibres, after the manner of temporary seasonings; while, at the same time, there is a habit formed of resisting the active causes (vitiating air) altogether, or of obtaining a permanent seasoning as to them.

“ The cold stage of a paroxysm is a state of direct debility, induced by the vitiated air breathed operating to subduct heat and oxygen from the body; and its termination is by the stimulus of the vitiated air being for that time worn out. The hot stage, which begins as soon as the temporary seasoning is induced, is a state of excitement brought on by the heat and oxygen now operating upon the accumulated excitability with additional force.—The sweating stage is formed after the subsidence of the excessive action of the body, and the consequent enlargement of the diameters of the vessels, whereby sweat is formed by the combination of hydrogen and oxygen, and the other secretions proceed again, as usual, in the several glands.

“ The length of interval between the paroxysms depends upon the strength of habit acquired.

“ The frequency of their occurrence will be proportioned

to the facility with which a temporary habit is broken or gives way.

“The cold stage is the most dangerous; and persons dying in it, die of the direct debility induced by the vitiated atmosphere they respire.

“The hot stage is less dangerous, and persons who die in it expire in a state of indirect debility. But, according to circumstances, death may happen in both the cold and hot stages.

“The sweating stage is a mere consequence of the cooling of the body, after the preceding heat and excitement of it.”

Our limits will not permit us to detail, at length, all the arguments that have been brought forward in support of this theory, by its author Professor Mitchill of New York, and by those medical gentlemen in America who have embraced his opinions. We have however endeavoured to give such a concise yet accurate account of the theory, and the grounds on which it is supported, as may enable those of our medical readers, who have not seen the American publications on the subject, to form some opinion respecting it. We give no opinion of our own—that does not belong to our province. It will not however escape the notice of medical men, that daily observation presents some facts which, on first view at least, do not appear reconcileable with this theory. Copper-plate engravers, in the course of their business, are often obliged to breathe an atmosphere loaded with septic (nitrous) gas, without appearing to be more liable to contagious diseases than other men; and, to mention no other fact of this kind, it has been proved, by the experiments made on board the Union hospital ship by desire of the Lords Commissioners of the Admiralty, of which we gave an account in our last Volume, page 68, that the fumes of the nitric acid are not only a cure, but an antidote against contagion. A. T.

XIV. *Description of a Machine for drawing Bolts in and out of Ships. Invented by CAPT. WILLIAM BOLTON of the Navy. From Transactions of the Society for the Encouragement of Arts, &c. Vol. XVI.*

THE gold medal was voted to Captain Bolton for this contrivance, a model of which is preserved for the use of the Public in the Society's repository.

A A A A A A (Plate IV.) is the frame of the machine. B, a cylindrical tube, having a female screw in the inside. C, a wheel with teeth attached to the cylinder B. D, an endless screw adapted to the wheel C. E, handle of the winch. F, the bolt drawing out. G G, blocks to support the frame. H, a hollow piece of steel, having on its outside a male screw, whose threads work within the female screw in the cylinder B. To this piece of steel the bolt is to be riveted. I, a semicircular piece of steel, which is to be introduced into the notches on H, when a similar notch has been cut in the head of the copper bolt, which by this means is prevented from turning in H, while drawing. K, the bolt, as prepared to receive the machine. L, a steel bar, somewhat smaller than the bolt to be drawn, having at one end a male screw, A, and at the other end another male screw that fits into the female screw in B. M, a section of a male screw, having a square hole larger than the bolt. N, a bolt with a male screw at one end ready to be drawn in.

The machine, of which a plate is annexed, consists of a frame supporting a cylindrical female screw tube. On this tube is mounted a wheel with teeth adapted to an endless screw fitted to the frame, and worked by a handle.

To draw the Bolt out.

The head of the bolt must be cut off, and a hole made in the timber big enough to receive the male screw H, which

is put over the bolt: a slit is then to be made, either by a saw or cold chissel, in the head of the bolt, to receive the key I, and which corresponds to the slit in H: the bolt head is then to be riveted as firmly as possible upon H: the cylindrical tube, B, is then to be screwed on, turning the whole machine round till it can be done no longer, when the endless screw is to be used. If the machine is of a proper strength, and the riveting well done, the power is such as to extract the bolt or break it, but generally it will be drawn out uninjured.

To draw Bolts into Ships.

It will be necessary to have a bar, L, which I recommend to be made of steel, long enough to pass from the inside to the outside of the ship, and somewhat smaller than the copper bolt intended to be drawn in. This may be called a conductor. On one end should be a male screw, *a*; the bolt to be drawn in should be tapped at one end to receive the male screw, *a*, on the conductor, and at the other end should be another male screw that fits into the female screw in B; after which the operation is the same as drawing a bolt out, and the machine should be applied accordingly. When the bolt arrives at its destined place, it may be secured on the inside by a nut, which is as good a way of fastening as clinching, and much more expeditious.

This machine, though only of the height of eighteen inches, will draw bolts in or out of any length; for, after the bolt has risen to the top of the tube, it will only be necessary to screw the machine back, and follow up the work with blocks of timber, as represented in the drawing.

Note. If the upper part of the hole in H be made square, larger than the round hole as shewn at M, and the head of the bolt riveted into it, it will do away the necessity of the key, I, render the machine less complicated, and save much time and trouble.

XV. *Description and Use of C. GUYTON'S Eudiometer.*

From Journal de l'Ecole Polytechnique, P. II.

CHEMISTS and Philosophers have long wished for an eudiometer capable of shewing exactly the quantity of oxygen gas mixed in any other gas. Berthollet has proved, in his Lectures at the Normal School, that the eudiometer of Scheele, which he justly considers as the best, has still great defects, as the absorption requires several hours, and as towards the end there is a decomposition of water, and consequently a disengagement of hydrogen gas, which occasions uncertainty respecting the quantity absorbed.

This induced me to seek for some substance which in a convenient manner might immediately give a more accurate result than nitrous gas, hydrogen gas, phosphorus, and a mixture of sulphur and iron, the only substances which, as far as I know, have been hitherto employed for that purpose.

Sulphure (sulphuret) of potash appeared to me fit to be tried under this point of view. I was well aware that at the ordinary temperature it is susceptible only of a combustion still slower and more insensible than a moistened mixture of sulphur and iron; but I presumed that, if the temperature were raised by applying a small taper, it would be sufficient to put in action the affinity, and to determine rapidly an absorption which would not then be affected by any foreign cause. The effect fully answered my expectation; so that the question then only was to determine the apparatus necessary to form this new eudiometric instrument. I thought that an inverted retort would unite simplicity, convenience, and every advantage that could be desired. The following is a description of it.

AB (Plate V.) is a small glass retort with a long neck, and capable of containing from 12 to 15 centilitres*. One must be chosen so much bent that, when the neck is placed vertically, the bulb may form in its lower part a cavity con-

* About eight cubic inches,

taining the matters introduced into it. The extremity of the neck is ground with emery to fit air-tight at C into the glass tube CD, open at both ends, and 20 or 25 centimetres in length. F is a cylindric vessel—a common glass jar, into which the tube of the glass CD may be entirely immersed below the surface of the water.

When you wish to try any aeriform fluid in order to separate its parts, and discover the quantity of respirable air it contains, put into the retort two or three bits of sulphure of potash of the size of a pea; fill it with water, taking care to incline it to make all the air which might remain in the bulb pass into the neck; stop with the finger the orifice of the retort, and place it in the pneumatic tub, that the gas to be tried may be introduced in the usual manner. By inclining it again, alternately in different directions, all the water may be easily displaced, and the sulphure left remaining in the bulb.

Then place the retort vertically, and introduce the end of it into the glass tube CD, which must still be under water; and place below the bulb a small lighted taper. To preserve the retort in its position, a cover of wood, with an aperture for its neck to pass through, should be fitted to the jar.

The first impression of the heat dilates the gaseous fluid, so that it descends almost to the bottom of the tube, which has been disposed on purpose to receive it, and to hinder any part of it from escaping, which would be the case if the tube were not sufficiently long, and which would prevent the diminution from being accurately determined. As soon, however, as the sulphure begins to boil, the water ascends with rapidity, not only in the lower tube, but also in the neck of the retort, notwithstanding the application or even augmentation of the heat. If it be vital air absolutely pure, the absorption is total. In that case, to prevent the vessel from bursting, which might happen were it cooled too suddenly, the ascent of the water must be retarded, either by removing the taper, or inclining the retort, which will not
hinder

hinder the absorption to continue, while there remains gas proper for maintaining combustion.

If it be common air or vital air mixed with any other gas, you must, after cooling, measure the quantity of water which has entered the retort, and which will exactly represent the bulk absorbed. You must not neglect to confine the remaining gas under the same pressure, by immersing the retort in the pneumatic tub, till the internal and external water be on the same level, before you close the orifice by a stopper. This operation, very easy when you have graduated vessels, may be made in common practice by means of a piece of paper cemented along the neck of the retort, and having traced out on it divisions determined by experiment, and which may be covered with varnish to defend it from the action of the water.

C. Chauffier has constructed, for eudiometric experiments by phosphorus, an apparatus somewhat different, composed of a long tube all of one piece, one end of which is bent and blown into a bulb, and having, as at *e*, a tubulure shut with a stopper after the water has been made to ascend in the inside of the tube to two-thirds of its height. This instrument would serve also for experiments with the sulphuret of potash; but I must observe, that the execution of it is not so easy as on the first view might appear. Besides, if the tubulure renders it very convenient for trying atmospheric air, the case is not the same in regard to other gases which cannot be introduced but by transmissiion.

XVI. *On the Component Parts of Iron-stones, and how these in the manufacturing affect the Quality of Crude Iron.*
By MR. DAVID MUSHET, of the Clyde Iron Works. Communicated by the Author.

IRON-STONES, though commonly denominated ores of clay, contain notwithstanding a variety of mixtures, and may with propriety be divided into the following classes:

1. Iron-stone that has clay for its chief component earth, and this clay comparatively pure and free from sand.

2. Iron-stone possessing lime for its chief mixture, and this lime also comparatively destitute of sand.

3. Iron-stone that unites clay and lime, containing large proportions of filix; hence, for distinction's sake, may be denominated filiceous iron-stones. I shall therefore, in naming these varieties, use the following terms as they are arranged in succession. Argillaceous, calcareous, and filiceous iron-stones. None of these earths exist singly with the iron. All iron-stones contain a mixture of the three, in various proportions; from which arise the supposed variety of the qualities of crude iron, which each respective stone is said to contain. There are some, however, which are composed of nearly the same proportions of clay, lime, and filix; and these commonly afford, when compared with themselves, a similar quality of crude iron.

Nature, in the formation of these secondary ores of iron, has invariably impressed characters upon them, easily to be developed: by which means their qualities, and the consequent effects produced in the blast-furnace, may be accurately and distinctly prejudged. The source of this information is, the study of the nature of the united earths; by ascertaining the quantity and proportion of which, we are enabled to pronounce exactly upon the quality of the iron likely to be obtained from the ore. We must not, however, consider these characteristic features as a consequence of the metal existing of a variety of qualities; but, *a priori*, we ought to consider, that, as a consequence of the nature and proportions of the mixture, the iron will be called into existence in a state more or less oxygenated or carbonated.

When iron-stones are said to contain *good* or *bad* iron, the expression ought to be understood, which by the bye is seldom the case, only as a comparative assertion, confined to local rules, and judged by certain fixed local standards; into the account of which many things must be taken, which are frequently overlooked. At every iron-work, a certain pro-

portion

portion of fuel, coaks or wood char, by weight, is understood to be sufficient to smelt, and give principle to a determinate weight and quality of iron-stones combined together, in order that a certain quality of crude iron may be produced. In this case, should a new iron-stone be substituted for one whose quality and effects are already known, and should its application be productive of iron less carbonated than formerly, it would instantly be denominated a *bad* iron-stone, or an iron-stone containing bad iron—an assertion only true comparatively so far as it would affect the interest of the manufacturer, unless corrected by an addition of fuel, a change of the mixtures of ores, or a varied application of the lime-stone used as a solvent or flux. But this is no proof that the quality of iron, as it exists in the ore, is bad, since a larger proportion of coaks, or a change of mixture, which incurs no additional expence, can correct the evil. It rather furnishes a demonstration that the iron in all ores is the same; but that, in calling it into a metallic form, the quality is affected chiefly by the reduction of those mixtures originally united with it.

As the quality of the fuel is improved in a direct ratio to the quantity of carbon which the coal contains, and its purity, hence arise the great variety of coaks used in smelting iron-stones; some of which will smelt, and give principle to the iron contained in double the weight of the same ores that others will. From this then may be deduced another proof, that *good* and *bad* iron are terms of comparative meaning only, confined to situation. Let it be conceived that a change of fuel opposite in its quality to that now mentioned was to take place; the same quantity of ore, which with the good coaks would have afforded metal richly carbonated, would now yield its produce in a partial degree, and that highly oxygenated—almost unfit for any purpose. The consequences here entailed are the same, though they may be attributed to different causes; the former as derived from the hostile mixture of the ore, but the latter as arising from a deficiency in the quality of the coaks.

Besides these two leading instruments of alteration in the smelting process, inherent in and derived from the materials, good and bad effects may be produced from an unjust proportion and quality of the lime-stone, which is added, in order that the proper equilibrium may be restored, and the iron properly and beneficially revived.

Taking this then for a general principle, that the crude iron contained in all iron-stones is the same, and that it can be called into existence as a metal of all the various degrees of carbonation, by regulating the proportion of fuel, and of the solvent; I shall proceed to mention those mixtures which I have always observed determine the future quality of the crude iron.

1. Argillaceous iron-stone having fine clay as its chief component earth, lime in the next proportion, and both these nearly destitute of sand; which, when properly torrefied, exhibits fibres on its internal surface, of a brown, dark-brown, or claret colour, running either in streaks or radiated, and adhering tenaciously to the tongue, will afford, with a moderate proportion of coaks and lime-stone, iron of the finest quality, possessing strength conjoined with an intimate degree of fusibility.

2. Calcareous iron-stone, that which contains lime as its principal earthy mixture; holding clay in the next proportion, and both these comparatively unallayed (totally they never are) with sand; which, when regularly torrefied, assumes a variety of shades generally lighter in the colour than the former class; which sometimes, and sometimes not, presents internal fibres, and which adheres less tenaciously to the tongue; always contains iron, which can be revived, richly carbonated with a comparatively small quantity of coaks, and with a trifling addition of lime. Under this class of iron-stones are found those which produce iron of a fusible nature, seldom connected with strength, but valuable for its utility in fine castings, which require ornament more than durability. It is also from this source of mixture that I would trace the red short quality of bar-iron. The
nature

nature imposed upon crude iron in the blast-furnace by the development of its mixtures, most commonly accompanies it through all its subsequent stages of existence as a metal.

3. Those iron-stones whose component parts are nearly an equalised mixture of clay, lime and sand, which torrefy with a slight degree of adhesion to the tongue, assuming a dark-red or brownish colour, void of internal fibre, always afford, with the local proportion of fuel, iron of an intermediate quality for fusibility and softness, but generally possessing strength in an eminent degree. Such iron is excellently adapted for the manufacture of great guns, mortars, and the large species of machinery. Its application to the purpose of bar-iron making, would also be attended with the most beneficial effects, possessing neither the extreme of fusibility nor of infusibility: it would greatly prevent, in the manufacturing, a tendency, which iron possessed of these extremes has, to become red or cold short.

4. Iron-stones which unite a large proportion of sand with sparing proportions of clay and lime, which, upon being slightly exposed to heat, exhibit masses of semivitrification, neither obedient to the magnet, nor adhesive to the tongue, having a refractory disposition to part, and possessing a dark-blue or black colour, always afford, with the usual proportion of fuel, crude iron of the worst quality, either as to strength or fusibility. Such metal is commonly highly oxygenated, and brittle; incapable of being used alone for any melting purpose; and, when applied to the use of the forge, affords malleable iron, which possesses the cold short quality.

These are the four principal classes under which I have arranged our iron-stones, with regard to their tendency to afford their iron carbonated, possessing strength, or otherwise, when smelted in the blast-furnace with a determinate quantity of fuel. As this classification is exactly analogous to the results obtained in the large way, it may serve as a ground-

work to those who may wish to attain a practical knowledge of these ores, so far as it relates to their manufacture.

It is however easy to counteract the natural tendency which every iron-stone has in this case, to afford its iron of a certain quality, and to make each of them yield crude iron of all the different degrees of fusibility and strength. Is it not obvious, that since the qualities of crude iron depend upon the mixtures and their kinds composing the stones, that if nature be assisted by adding or subtracting from them in the blast-furnace, every quality of crude iron may be produced from the same iron-stone? I have seen most of these results determined in the large way, and the whole of them beautifully confirmed in the assay-furnace.

It remains with the present manufacturer to consider whether it will be more his interest to reject such iron-stones as are of difficult carbonation, or to apply the necessary additional proportions of fuel, capable of correcting the quality of siliceous iron-stones. Not so, however, to those who may at some future period succeed him; necessity, at all times ingenious, assisted by the increasing light which science daily sheds over our manufactures, will devise the means of calling into profitable existence the metal contained in all those ores which may have fallen into disrepute in the present day, or from which at this time it is thought impracticable to extract metal in the large way.

The usual criterions by which iron-stone is judged, whether it be sufficiently rich in iron for the purpose of smelting, are the following:

1. The degree of tenacity with which it adheres to the tongue after torrefaction: 2. Its colour: 3. The obedience to the magnet when pulverised: 4. By depriving of its iron a given weight of the ore, in contact with charcoal and fusible earths in the assay-furnace.

The first and third of these methods are liable to great error. The adhesion to the tongue will be more in proportion

tion to the quantity of clay and its kind contained in the stone, than to its real contents in iron. Iron-stone may also be torrefied in such a manner as to deprive its internal surface of this property; as it is only peculiar to the stone at a certain stage of torrefaction.

The influence which the magnet possesses over some ores of iron is no direct proof of the quantity of iron contained; as some ores which contain 15 parts in 100 are completely magnetic, while others again that contain 60 to 70 parts of iron in 100 are not in the smallest degree affected with this property. The magnetic test is more used to ascertain the existent state of the metal, whether mineralised with an acid, combined with sulphur or with oxygen, or existing in a disengaged state more or less metallic. No iron-stones which in their native state contain their iron mineralised with oxygen, or in the state of an oxyde, completely dispersed through an intimate combination of clay, lime and flint, containing water, carbonic acid, and sometimes concrete sulphur, are obedient to the magnet till such time as torrefaction has passed upon them, either exposed to open air, or in contact with charcoal in close vessels. If this process is continued for a short time, the whole mass will become obedient; but this affection will still depend upon the relative quantity of concrete oxygen fixed with the iron. Individually, however, iron-stones are affected by the proportion of heat conveyed to them while torrefying. If the quantity communicated has been sparing, so as not to have carried off all the water, carbonic acid, &c. the magnetic virtue will also be proportionally absent: if the dissipation of these substances has been complete, the magnet will possess an influence in the exact ratio of the quantity of oxygen which remains combined with the metal. Should it happen that a degree of heat capable of exciting fusion is applied, the mass will then rapidly lose its magnetic obedience by an extra-fixation of oxygen; if driven so far as to make it exhibit a semi-vitri-

fied appearance, this principle would be found to be entirely annihilated.

Although the colour which iron-stones assume in torrefying intimately depends upon the degree of heat presented to them in the operation of burning, yet, by regulating this agent in a proper manner, an accurate knowledge may be formed, not only of the probable quantity of iron, but even of its tendency to become carbonated in smelting. The expulsion of the water and acid leaves the combined earths more exposed to determination. The small specula of filix are distinctly discerned; adhesion to the tongue develops the presence of clay; and lime is indicated by its assuming a whitish colour, either striated, or disseminated, approaching towards the surface of the stone.

The last method mentioned, namely, that of depriving a given portion of ore of its iron, is the most consonant to truth and to the ideas of the manufacturer. Acids may be used as a check upon the assay by fusion; but this intricate, or rather this slow process is chiefly resorted to by chemists, and seldom goes beyond the bounds of the laboratory. In assaying by fusion, not only the quantity of iron may with precision be ascertained, but also the quality of crude-iron likely to be produced from the ore, with the local proportions of fuel in the large way. The earths formerly united with the iron, now become fused with those added for solvents. These float upon the surface of the extracted metal, and, when cold, may afford information, from their colour and transparency, concerning the regulation of future proportions upon a more extended scale. This subject I shall more minutely illustrate in a subsequent paper on the assaying of iron-ores by fusion.

The burning or torrefying of iron-stones, known in the large way by the rather improper term of *calcination*, consists in exposing the stone to a certain degree of heat in contact with air, in order to dispel those substances which it contains,

contains, capable of assuming the aëriform state by the combination of caloric. This operation ought to be performed in a progressive heat, always short of fusion. The water is then slowly evaporated without being decomposed; the caloric unites to the carbonic acid, which soon assumes the gaseous state; and lastly, the sulphur, if any, sublimates.

This process is essentially necessary to be performed before the iron-stone is introduced into the blast-furnace. Were raw iron-stone, or ore, precipitated in the violent heat of the smelting-furnace, the water and acid would instantly be decomposed; the oxygen would partly unite to the iron in addition to the fixed quantity peculiar to each ore, and part of it would oxygenate the sulphur, either of the ore, or of the pit-coal, a portion of which is always present in the furnace. The whole mass would then be precipitated in fusion, and a dark porous lava obtained, containing iron more difficult to be revived than ever, owing to the great quantity of oxygen combined with it. In cases of this kind, the disengaged hydrogen manifests its escape, by changing the colour of the flame from a mellow white to a pale sickly blue.

It must from all this appear obvious, that, when torrefaction has been properly conducted, a very considerable part by weight of the whole will be dissipated: the absence of these volatile substances always leaves the iron-stones more or less magnetic. The loss of weight, however, is very different in the various classes of iron-stones, even when they are all exposed for the same length of time to a degree of heat capable of expelling those mixtures, which, under such circumstances, assume the gaseous state.

1. Calcareous iron-stone, when properly exposed to torrefaction, loses more of its weight than either of the other two classes. Where the lime is abundant, I have found this iron-stone lose 38 per cent. but more commonly 35 and 36 per cent. of water, carbonic acid, and sulphur.

2. Ar-

2. Argillaceous iron-stones, exposed to a similar degree of heat, and treated in the same manner, commonly lose in weight from 32 to 35 per cent.

3. Siliceous iron-stones always give out less weight when exposed to torrefaction under similar circumstances with other stones. In common they lose from 27 to 30 per cent. I have, though rarely, found them to give out 25 per cent. only.

The extreme loss of weight in each class must be considered as the utmost point to which torrefaction can with safety be urged, without exposing the iron-stone to an accumulation of weight by the combination of oxygen.

From the variously compounded natures of iron-stones arise the various calculations of the loss which they are said to sustain in burning, at different iron-works. Fields of iron-stone are commonly impressed with a general distinguishing characteristic feature: some are of the calcareous genus; some of the argillaceous; and others again have a more intimate alliance with flint than the former two. Hence we find, at those works where the chief supply is drawn from the argillaceous iron-stones, that the loss in torrefaction on the great scale is computed from 30 to 33 per cent. Where calcareous iron-stones form the chief supply, the loss is estimated at from 35 to $37\frac{1}{2}$ per cent. Few or no iron-works are obliged to have recourse to iron-stones abounding with sand for their chief consumption: a general estimation of the loss sustained by this stone in the large way is therefore difficult to be made, though, I have heard, that at some works 25 per cent. was all that was allowed to be expelled during burning. Nature has been extremely kind in the formation of our secondary ores of iron; as the bulk of them, that contain iron sufficient to entitle them to be smelted, are combined with superior proportions of clay and lime.

As the burning or torrefying of iron-stones is of great importance

portance to the manufacturer, and as it may be in some respects gratifying to the man of science, I shall particularly enter into the various phenomena attending the operation; dividing torrefaction into two classes: that which deprives iron-stones of certain substances capable of becoming aëri-form by the combination of caloric in contact with atmospheric air; and that which deprives ores of their oxygen—hence called de-oxygenation—by heating them in contact with charcoal, in closed vessels, or in cavities impervious to the external air.

1. The consequences of heating iron-stone exposed to air is a loss of water, sulphur, and carbonic acid*. A small portion of oxygen may at times be unfixed, when the fuel may chance to come into contact with the heated iron-stone under a partial exclusion from air. But the association of circumstances necessary to effect this can so seldom be the effect of chance, that it is never to be looked for with certainty. When the operation is properly performed, the last particle of acid and water may be expelled. But this point is difficult to be ascertained with any degree of exactitude: for, in proportion as these gaseous substances are carried off, the metal becomes more and more revived, of course more and more liable to attract, and fix oxygen by the decompo-

* I have seen some iron-stones in torrefying deposit a beautiful oxyde upon their surface, of a lake colour, and light as down. The same substance, I have observed, effloresced upon the surface of the fracture of highly oxygenated crude iron, which had been broken immediately after the metal had lost its fluidity. From this coincidence of effect, I am inclined to suppose, that the oxyde deposited on the iron-stone in burning is the consequence of the decomposition of the sulphuric acid; a portion of which had been mineralised with the stone, holding iron in solution: and that in the latter it was occasioned by a superabundance of oxygen in the blast-furnace, probably from the introduction of raw iron-stone, which had escaped the effects of the fire: that the sulphur, as formerly stated, had become oxygenated, dissolving a portion of the metal; which was again deposited in the state of a calcined sulphat, when the acid was suffered to escape, by being freely exposed at a high degree of heat to open air.

fusion of the ignited gas; and, as the last portions of the acid and water are distilling, the stone is apt to gain weight by the calcination (oxygenation) of its iron. This will positively be the case when the heat is carried beyond the necessary degree, and is indicated by the iron-stone swelling in bulk, becoming specifically lighter and porous on the surface, but gaining weight in a great degree internally. As oxygenation goes on, the magnetic virtue decreases, until at last it becomes entirely annihilated.

The first stage in torrefaction is indicated by the first general change of colour in the iron-stone. This is commonly a faded blood colour, more or less dark according to the quantity of lime present.

I have repeatedly made use of all the various iron-stones, in the state of a fine powder, in order to ascertain what was the weight lost by each class in its transition from its native hue to the first stage of an assumed colour. And I am enabled to state the following as an average of the results obtained on this head: Calcareous iron-stones give out 6 parts in 100 of the raw mineral; argillaceous iron-stones, 5; and siliceous iron-stones, $4\frac{1}{2}$.

If the pulverised iron-stone is thrown into a vessel red hot, this loss will be effected in two minutes. The change of colour is immediately effected on those parts in contact with the heated iron. The whole is brought into contact with it; and when thrown out, the magnet will be found to have acquired a perceptible influence over it. When the powder is first thrown in, a slight decrepitating noise is heard for a few seconds. This operation may also serve to shew the presence of sulphur, or of its acid. When in the former state it instantly takes fire, and burns with a dark lambent flame. When the acid is present, it is easily known by the suffocating fumes disengaged by the action of heat.

The application of heat beyond the first stage of colour, causes the iron-stone to pass through a variety of shades.

These,

These, as in metallic substances, are the effects of the presence of air at certain degrees of heat*. As the progressive dissipation of the volatile mixtures takes effect, the colour deepens; and, according to the nature of the iron-stone, becomes fixed, of a brown, dark brown, or deep claret colour. These indicate the almost entire expulsion of the water, acid, &c. In this state all iron-stones are possessed of magnetic attraction, and exhibit the various phenomena already described, as being peculiar to their respective natures.

The methods commonly in use for torrefying iron-stone, in the large way, are of two different kinds: that of burning in kilns or conical furnaces; and that of exposing iron-stone in open air, stratified with coals, to combustion. The former is used in some places in Wales; the latter is almost universally adopted in England, and totally so in Scotland.

In the operation with furnaces, they become filled entirely with iron-stone, except a stratum of coals in the bottom, which is afterwards inflamed. The combustion is then carried on by means of a current of air passing through the furnace, and forcing the heat along with it. When the iron-stone is deemed sufficiently burnt, the register is shut up; and the combustion, no longer maintained by means of external air, soon dies away, and leaves the furnace to cool.

The most common method, however, of burning iron-stones, consists in levelling a piece of ground, and covering it with a layer of small pit-coals. This is of various thicknesses, 4, 6 or 8 inches, according to the height the pile is to be built, and the nature of the iron-stone. Upon this stratum of coals the pieces of iron-stone are imbedded, as near to the same size as possible, in order that all may be equally acted upon. These are reared to various heights,

* From smooth-surfaced iron-stones and ores, when exposed to heat partially sheltered by charcoal dust from the action of air, I have obtained all the shades of colour peculiar to polished iron and steel; but with less of the metallic lustre, owing to the surface being more porous.

18, 20 to 24 inches, the determination of its height depending upon circumstances. The surface is a second time levelled, by introducing small pieces of iron-stone betwixt the interstices occasioned by the angles of the larger. This again receives a covering of small coals, seldom exceeding 2 inches in thickness. Upon this is reared the subsequent building, always gradually narrowing itself till it has assumed the shape of a stout wedge, with its base resting upon the ground. After this is effected, the whole of the external surface receives a complete covering of the smallest sort of coals. The pile is kindled by applying burning coals to the ground stratum. This creeps slowly along; heats the stone upwards; kindles the second layer of small coals, and ultimately inflames the whole mass from top to bottom.

When the coals are consumed, the pile gradually cools, and in 8 or 10 days may be wheeled away to the furnace.

The quantity of iron-stone burnt at one time is various at different and even at the same places; some kinds require to be burnt in smaller heaps, owing to their nature and fusibility. At some works the fires extend from 50 to 60 yards; and it is not uncommon to see skilful workmen, at one end, adding fresh materials to the burning pile; while others, at the opposite end, are employed wheeling away that which the fire has left sufficiently burned for the purpose of the furnace. Fires that extend from 30 to 60 feet in length are more common; from 10 to 16 feet wide, and about 5 feet high.

At most iron-works a local opinion exists, to what degree of heat iron-stone ought to be exposed before it is properly fit for the blast-furnace. All, however, agree that burning is necessary; though few give an accurate reason why. The only one I have heard adduced is, that iron-stone is *calcined* in order to burn out the sulphur and other *heterogeneous* mixtures. Hence arise a diversity of opinions, chiefly founded upon individual notions of the fixity or volatility of sulphur.

fulphur. Some contend that sulphur is easily displaced, and that therefore the iron-stone should be moderately *calcined*; lest the sulphur from the coal used in burning it should enter, and again hurt the quality of the iron. On the other hand, it is said that sulphur is of difficult expulsion from the centre of the stone, as it is never seen going off till a bright red heat forcibly expels it; and therefore it is highly requisite the iron-stone should be long and violently exposed till the last portion is got rid of. To effect this, therefore, the heat, say they, ought to be urged till such time as the stone has indicated signs of fusion, or has partially suffered thereby. In order to give strength to this opinion, those who adopt it add, that, by such severe *calcination*, the volume of stone is reduced, becomes heavier, and that it will consequently occupy less room in the blast-furnace; of course it is imagined that, bulk for bulk, the iron-stone becomes richer in iron than when in a raw state.

Those who are acquainted with the oxydation of metals, and the consequent increase of weight, will at once discover the source of this error, and readily conceive, that, after the metal in the iron-stone has become partially disengaged by the expulsion of water, carbon acid, sulphur, &c. forming frequently a third part of the whole weight, it will become an object of attack to the oxygen of the atmospheric air; the combination of which with the iron alone adds to the actual increase of weight, and not the transposition of the particles of metal from one piece of iron-stone to another. It must also be obvious that, where such fallacious prejudices have taken root, the consequences must frequently be fatal to the interests of the manufacturer; as such iron-stones, literally calcined, must require an additional portion of fuel to furnish carbon to carry off the superadded oxygen.

It is somewhat remarkable that the phenomena attending the oxydation of iron should be entirely unknown at iron manufactories. Such a process is never dreamt of, and even the declaimers against severe torrefaction only account

for

for the increase of weight, by asserting that the earthy parts are burnt out and nearly consumed, and that the metallic parts only remain, destroyed however in their nature and *reduced to a cinder*.

We are not to wonder, therefore, at the uncertain results which the untutored manufacturer obtains, until such time as a long course of experience has taught him, that, by combining certain causes, good or bad effects are the consequence. Even at last he still rests upon an unstable basis: destitute of the correct operation of principle, and incapable of preventing an evil from a total ignorance of its real source of action, he can only in the end avoid it after a multiplicity of movements, wherein he finds his practical knowledge increased at the expence of a considerable sacrifice of property.

How much more enlightened would be the mind of the manufacturer, were he to attend minutely to the phenomena developed in all the stages of his process, and satisfy himself as to the radical principles of action in each individual stage! In doing this, chemical minuteness, the terror and butt of the unphilosophised mind, is not absolutely indispensable; and yet every thing may be ascertained necessary to be known for the production of certain determinate qualities of crude iron.

He would then easily comprehend that all iron-stones contain less or more water of crystallisation, and that, being combined with a certain proportion of lime neutralised with carbonic acid, it is necessary that they be exposed to a heat sufficient to expel the first and last of these as well as sulphur. The reason has already been given, and the consequence shall be once more stated. The evil effects produced by introducing raw iron-stones into the blast-furnace, are less owing to the small portion of sulphur contained in most of them, especially in balls, (the vapours of which arise even from the softest crude iron when fluid,) than to the decomposition of water and acids, each of which gives up
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a proportion of oxygen to the metal, chiefly before separation is effected.

Does it not then unquestionably follow, that if the quantity of charcoal in the furnace formerly was sufficient to take up the oxygen existing in the ore, and to afford carbonated crude-iron, that if a further quantity of this principle is added, by whatever means, part of the charcoal which formerly went to carbonate the iron now combines with the superadded oxygen to form carbonic acid; of course the metal will be deprived of its carbon, become white in the fracture, and may then justly be denominated oxygenated crude-iron. The same application to principle would also inform the merely practical man, that when iron-stone is completely deprived of those substances which assume the gaseous state by the combination of caloric at a moderate temperature, it is then sufficiently prepared for the furnace. This is always indicated by the colour which the stone assumes varying from a brown to a dark claret. Blues always succeed this shade; and the smallest appearance of blue, however light, is a certain sign that the external air has made an impression upon the particles of metal, by superoxygenating them. Instead therefore of expelling a further quantity of *heterogeneous* matter, a principle is added the most noxious and destructive to the existence of iron in a metallic form.

The phenomenon of iron-stone becoming heavier in the fire, would no longer be explained by assuming vague assertions incompatible with and inadmissible to common sense. Upon finding two pieces of iron-stone in the same fire, which have to appearance been affected in a widely different manner by the heat; the one heavy, of a black blueish colour; the other light and porous: the practical man would now no longer say that the metal from the porous piece had escaped by these pores, and entered into the ponderous one; and that the accumulation of weight in the latter was entirely owing to it abstracting the metal

VOL. III. P from

from the former. Widely different indeed would be the conclusion. He now would have learned that metals are combustible bodies; that under certain circumstances iron is one of the most inflammable in the group; that, during its combustion, it decomposes the air that maintains the combustion, and fixes one of its elements in spite of the powerful affinity exerted upon it by the caloric; and that by this process alone it increases its volume and weight. The porous mass of iron-stone would now be described as having had its iron completely saturated with oxygen at a very high temperature; that an imperfect state of fusion had been the consequence; and that a combination of these circumstances, acting for a considerable length of time, had volatilised and carried off a very considerable portion of the metal.

On the same principle would be explained the increase of weight in the more ponderous piece; it would then readily be conceived, that the same association of circumstances had not been present; but that the iron had gained in weight by the addition of oxygen at a temperature short of fusing and volatilising the oxyd.

What I have further to state on this subject shall be forwarded for the next Number of the Philosophical Magazine. In the mean time I shall subjoin a few remarks which may be considered in the light of a

Postscript to the Paper on the Principles of Iron and Steel.

In that paper (Phil. Mag. Vol. II. p. 165) I stated that the carbon which exists in steel is in an elastic or aëriiform state. In a long series of experiments which I made on the dissolution of crude-iron and steel in various acids and in water, I always obtained carbon from the former in a crude concrete form; but the carbon in steel always eluded my search, and never appeared till some days afterwards, in the manner of a greasy pellicle, thin and transparent upon
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the surface of the fluids. This circumstance confirmed what had long been evident to me, from a knowledge of the principles and the mode of conveying them in manufacturing both these states of iron, that the carbon in crude iron and that in steel existed in a widely different mode of union. And as in the latter it existed not in a crude state, I was led to conclude that an aëriform chemical union was effected, during the process of cementing the steel, by the agency of the caloric on the charcoal, which stratifies the bars during the operation.

In my correspondence, however, with the Editor of the Philosophical Magazine, he threw out some hints that a different kind of chemical union might be effected by the same agency, and that in steel the carbon might exist in a concrete state, though not crude—neutral, though not aëriform. This combination, which I had overlooked, (*humanum est errare!*) appeared so highly probable that I resumed my experiments; and I am happy in now stating that this idea was just, as I have since obtained from steel carbon in the state of an impalpable powder, by the following simple operation.

I introduced into a glass vessel a plate of polished steel, and poured upon it as much clear rain water as covered it three inches. In this state it remained for 50 days, during which time I carefully observed the agency of the water upon the metal. Twenty-four hours after introduction, minute flakes were observed floating lightly in the water; they increased on the second and third days, and fell gradually towards the bottom. As these accumulated, the surface of the water became covered with the same carbonaceous pellicle mentioned above*, exactly resembling the coloured film which is frequently found floating upon the surface of springs where iron is precipitated from the carbonic acid.

* A plate of pure malleable iron underwent a similar immersion in a separate vessel, but exhibited no disengagement of carbon in this state.

During the immersion of the steel, a double affinity was exerted; part of the oxygen of the decomposed water united to the carbon to form carbonic acid: this union was at any time highly facilitated by raising the temperature of the water. The precipitate and oxyd upon the surface of the plate then became covered with transparent bubbles, which remained if the temperature was decreased; but on the contrary rose to the top and escaped, if the heat was augmented. The other affinity excited was that of the oxygen upon the iron; which it slowly oxydated, covering the surface at first with a slight yellow membrane of the thickness of gold leaf. This daily increased, and at the end of fifty days had acquired firmness and consistency. After carefully drying the plate, I began to separate the oxyd from the surface. This easily parted in scales, and under it I found the surface of the plate entirely covered with fine carbon, without grease or the smallest asperity. When strewed in the fire, it sparkled and exhibited the same characters as charcoal.

This experiment proves clearly that carbon exists in steel in a concrete state, though not crude—in chemical union, however, and not as a mere mixture as in crude iron.

I cannot conclude this note without —————*, and expressing a hope that the confirmation of this fact may lead to a solution of many of the phenomena attending the manufacture of iron.

* The author here pays us a compliment to which we have no claim, and having already inserted enough of what respects ourselves to show that we would not willingly disobey his commands, we hope he will excuse this small chasm. EDIT.

XVII. *A remarkable Case of internal Pain in the Heel, and an incipient Mortification, cured by the Inhalation of Vital Air : being the Third Communication from Dr. THORNTON, Physician to the General Dispensary, and Lecturer on Medical Botany at Guy's Hospital, relative to Pneumatic Medicine.*

MRS. FRITH, æt. 45, wife of the Rev. William Frith, rector of Kentish Town, for nearly four years experienced the most violent pain in the neighbourhood of the heel, which she could compare to nothing but the burning of a caustic. Various outward applications had been made, and medicines taken internally, without any alleviation. When Mr. Cruikshank, lecturer on anatomy in the school of Dr. Hunter, called me into consultation, there was extended over the heel a wound about the size of a crown, very dark, the edges livid; and the foetor from it was so intolerable that, when her maid had occasion to remove the dressings, she had always volatiles applied to the nostrils to prevent her from fainting. The countenance shewed a livid paleness, the pulse was quick and tremulous, and the slightest exertion produced faintings. The bark, opium, and wine, were continued. This lady inhaled also six quarts vital air mixed with twelve of atmospheric, and in a few days, as this respectable family can also testify, the livid hue of the wound disappeared, it had a more healthy appearance, and the discharge was so greatly improved, and foetor gone, that when the smelling-bottle was presented to the servant, she said that there was not the least occasion for it. In a fortnight the sore was completely healed, the appetite restored, and countenance so greatly improved that every friend marked the sudden alteration; the violence of the internal pain lessened by degrees, and the superoxygenated air being continued for a few weeks longer, it altogether subsided; and this lady for these last six months has enjoyed

uninterrupted health, and is able, at pleasure, to walk up Highgate-hill.

As many persons might wish to see the lady's journal in her own words, I here subjoin it, with a few observations.

“September 13. 1798. First inhaled the vital air. Felt acute spasms in the chest, and fainted.”

Observation. Artificial inhalation is accompanied with increased action of the intercostal muscles, and gives frequently afterwards a sensation of muscular pain, which speedily goes off, and after a few trials does not appear again. The second effect we always see in those very weak, and hence the expression of “*being overpowered by the air.*” Patients labouring under scurvy, if suddenly exposed to a clear air, are killed instantaneously.

“September 15. Felt a most pleasant glow after the inhalation of the vital air. Spirits also much increased, feeling as if a great weight, or oppression, was removed.

“September 16. The hardness about the heel gone, as also the fœtor. Has less discharge. The wound looks redder. The glow after the inhalation of the vital air lasts for about a quarter of an hour.

“September 18. The glow, and spirits, after the last inhalation, lasted four hours. Feel wonderfully light, and pleasant.

“September 20. Asked by my apothecary, ‘Whether I did not feel, from the inhalation of the vital air, an *uncomfortable heat*?’ My answer was, that it produced the most pleasant glow imaginable, not at all resembling *heat.*”

Observation. Putting the thermometer under the tongue, the sensible heat was not increased. This effect may perhaps be accounted for from the increased sensibility of the nerves; or, does the insensible perspiration raised by the capillaries of the skin being filled by the greater energy of the heart, account for this phenomenon better? I have almost invariably found the inside of the palm of the hand, after,
and

and during the inhalation, break out in a pleasant moisture, which are parts somewhat remote from the heart.

“ October 4. The pain in the heel infinitely more lively. The pain is a *new pain*; but, thanks be to God! it remits for three or four hours every day.”

These are the chief particulars: the nature of your Magazine may not admit of a further detail, nor does the nature of the case seem to require it.

General Observation. The change of colour in the wound, so immediately after the inhalation of the vital air, seems to indicate a remarkable change wrought in the blood. It is not, however, the temporary increase of oxygen only in the system, that this partial inhalation produces; for it renders the blood also more attractive of this principle. Hence the continuance for some time, even in London, among people of fashion, of the good looks acquired in the country; hence the pallid countenance of the man lately recovered from suffocation, or drowning; and hence also the return of the breath in patients under this treatment being more and more noxious, from a greater absorption of oxygen. The deterioration of the air inspired, has ever indicated the attractive power of the blood. Hence also it is that substances abounding in hydrogen are called cordials, from their sympathetic action on the heart, through the medium of the blood: but in the superoxygenated air we have a more direct action on the heart, without exhausting the irritable principle, and occasioning indirect debility; and I trust I shall be able to make it evident to the unprejudiced mind, that this is a great desideratum in surgery and medicine, more especially where diseases are remote from the heart; or else, why do we so frequently hear of *fore legs*, but never of *fore arms*? But, however the *modus operandi* of these new powers may be, the observance of *facts* is of greater importance; and I here beg leave publicly to thank those ingenious medical gentlemen who have honoured me with their correspondence on this subject, the result of which will be laid before the philosophic world.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

ROYAL SOCIETY OF LONDON.

AT the meeting of this learned body on the 21st of February, a work of great utility to astronomers was read—Dr. Herschel's 4th catalogue of the fixed stars, with their comparative brightness.

On the 28th of February a meteorological paper by Mr. Hutchinson was read; and a curious paper on the submerged forests on the coast of Lincolnshire, endeavouring to ascertain the epoch of the phenomenon, and containing geological observations on the different states in which trees are found in the earth, by Mr. Joseph Serra de Correa.

The meetings of March 7th and 14th were occupied in reading a curious paper on hermaphrodites; which contains also an account of some singular experiments on human generation, similar to those made by Spalanzani on the canine species.

INSTITUTION

For diffusing the Knowledge, and facilitating the general Introduction of useful Mechanical Inventions and Improvements; and for teaching, by Courses of Philosophical Lectures and Experiments, the Application of Science to the common Purposes of Life.

OUR readers will be happy to learn that a new Institution under the above title, which promises to be of great public utility, has been set on foot in this capital, and is expected shortly to be established by Royal charter. The Right Hon. Sir Joseph Banks, who has so long, and with so much

honour

honour to himself, presided over the Royal Society, and whose ardour in pursuing whatever objects may tend to promote the interests of science can only be equalled by his liberality in devoting to their advancement a large portion of a princely income, has given every aid, by his own personal exertions and his extensive influence, to give effect to the plan of this Institution, which was projected by Count Rumford, the strenuous advocate for the application of science to the common purposes of life.

We shall give such a sketch of the plan as our limits will allow, extracted from Count Rumford's original proposals for forming the Institution, which may be had (Price 6d.) of Messrs. Cadell and Davies.

The two great objects of the Institution are, the speedy and general diffusion of the knowledge of all new and useful improvements, in whatever quarter of the world they may originate; and, teaching the application of scientific discoveries to the improvement of arts and manufactures in this country, and to the increase of domestic comfort and convenience.

Rooms will be prepared for the reception and public exhibition of all new and mechanical inventions and improvements worthy of notice; especially of all such as tend to increase the conveniences and comforts of life, to promote domestic economy, to improve taste, or to promote useful industry.

Perfect models, of the full size, will be exhibited in this public repository, of all such new mechanical inventions and improvements as are applicable to the common purposes of life. Under this head is included: Cottage fire-places, and kitchen utensils for cottagers; a complete kitchen for a farm-house, with all the necessary utensils; a complete kitchen, with kitchen utensils, for the family of a gentleman of fortune; a complete laundry for a gentleman's family, or for a public hospital; several of the most approved stoves for heating rooms and passages.

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The machinery exhibited will, as far as possible, be shewn in action, or in actual use.

Open chimney fire-places, on the most approved principles, will be fitted up as models in the different rooms; and fires will be kept constantly burning in them during the cold season. Ornamental as well as economical grates, for open chimney fire-places, will also be exhibited; ornamental stoves, in the form of elegant chimney-pieces, for halls, drawing-rooms, eating-rooms, &c.

Working models of the steam engine; of brewer's boilers; of distiller's coppers with improved condensers; of large boilers for the kitchens of hospitals; and of ship's coppers; all with improved fire-places.

Models of ventilators; of hot-houses; of lime kilns; of boilers, steam-boilers, &c. for preparing food for cattle that are stall-fed; of cottages.

Various spinning-wheels and looms, with such other machinery as may be useful in giving the poor employment at home.

Models of all such new-invented machines and implements as bid fair to be of use in husbandry; of bridges, on various constructions; and of all such other machines and useful instruments as the managers shall deem worthy of the public notice:—each article exhibited to be accompanied with a description of it properly illustrated by correct drawings, the name of the maker, the place of his abode, and the price.

A lecture-room will be fitted up, and a complete laboratory and philosophical apparatus, with the necessary instruments, be provided for making chemical and other philosophical experiments.

Men of the first eminence in science will be engaged as lecturers; and no subjects be permitted to be discussed but such as are strictly scientific, and immediately connected with that particular branch of science publicly announced as the subject of the lecture.

Among

Among the branches of science, that will occasionally be made the subjects of these public lectures, are the following:

Of heat, and its application to the various purposes of life; of the combustion of inflammable bodies, and the relative quantities of heat producible by the different substances used as fuel; of the management of fire and the economy of fuel; of the principles of the warmth of clothing; of the effects of heat and of cold, and of hot and of cold winds, on the human body, in sickness and in health; of the effects of breathing vitiated and confined air; of means to render dwelling-houses comfortable and salubrious; of the methods of procuring and preserving ice in summer, and of the best principles for constructing ice-houses; of the means of preserving food in different seasons and climates; of the means of cooling liquors without the assistance of ice; of vegetation, and of the specific nature of those effects that are produced by manures; and of the art of composing manures, and adapting them to the different kinds of soil; of the nature of those changes that are produced on substances used as food in the various processes of cookery; of the nature of those changes which take place in the digestion of food; of the chemical principles of the process of tanning leather; and of the objects that must particularly be had in view in attempts to improve that most useful art; of the chemical principles of the art of making soap; of the art of bleaching; of the art of dyeing; and, in general, of all the mechanical arts, as they apply to the various branches of manufacture.

The money necessary for defraying the expence of forming this Institution, and also for the future expence of keeping it up, is to be raised: 1st, By the sums subscribed by the original founders and sole proprietors of the Institution, at fifty guineas each person, to be but once paid. 2dly, By the sums contributed by those who shall subscribe for life, at ten guineas each person, to be but once paid. 3dly, By the sums contributed by the annual subscribers, at two

guineas per annum for each person. 4thly, By the particular donations and legacies. And lastly, by sums received at the door from strangers who visit the Repository, or obtain leave to frequent the Lectures.

Each original subscriber or proprietor, besides other privileges, will be an hereditary governor of the Institution; have a perpetual transferable share in all the property belonging to it; a voice in the election of the managers of the Institution, as also in the election of the committee of visitors; two transferable tickets of perpetual admission into the establishment, and into every part of it; two transferable tickets of admission to all the public philosophical lectures and experiments; and may recommend persons for admittance to the philosophical lectures and experiments.

Each subscriber for life will receive one ticket for life, but not transferable, of free admission into the Institution, and into every part of it; together with one other ticket for life, but not transferable, of free admission to all public philosophical lectures and experiments.

Each annual subscriber's tickets will be for one year, but not transferable.

Subscribers for life, and annual subscribers, as well as the proprietors of the Institution, will be entitled to have copies or drawings (made at their own expence) of any of the models in the repository, and this even when such copies are designed for the use of their friends; and workshops will be prepared, and workmen provided under the direction of the managers for executing such work properly, and at reasonable prices.

Persons employed in executing work after any of the models, will, on the recommendation of any subscriber, be allowed access to such model as often as shall be necessary: and such of them as shall be willing to furnish to buyers any article exhibited in the repository, will be allowed to place a specimen in the repository, with his name and place of

abode attached to it, and the price at which he can furnish it; such specimen having been examined and approved by the managers.

The design or object of the Institution is not to give rewards to the authors of ingenious inventions, but to diffuse the knowledge of such improvements as bid fair to be of general use, and to facilitate the general introduction of them; and to excite and assist the ingenious and the enterprising by the diffusion of science, and by awakening a spirit of inquiry.

In order that the proprietors of the Institution, and the subscribers, may have the earliest notice of all new discoveries and useful improvements that shall be made from time to time, not only in this country, but also in all the different parts of the world, the managers will employ the proper means for obtaining, as early as possible, from every part of the British empire, and from all foreign countries, authentic accounts of all such new and interesting discoveries in the various branches of science, and in arts and manufactures, and also of all such new and useful mechanical improvements as shall be made; and a room will be set apart in the Institution, where all such information will be lodged, and where it will be kept for the sole and exclusive use and inspection of the proprietors and subscribers, and where no stranger will ever be admitted.

Several resolutions adopted at a general meeting of the proprietors, held at the house of the Right Honourable Sir Joseph Banks, Bart. K. B. in Soho Square, on the 7th day of March 1799, having been published in the daily papers, need not be here repeated.

The following list of the proprietors, and original subscribers of 50 guineas each, deserves, however, to be recorded in the present account of the Institution:

Sir Robert Ainslie, Bart.

Scrope Bernard, Esq. M.P.

I. J. Angerstein, Esq.

The Earl of Beaufborough.

Right Hon. Sir Joseph Banks, K. B.

Rowland Burdon, Esq. M. P.

Thomas Bernard, Esq.

James Burton, Esq.

Timothy

Timothy Brent, Esq.	Thomas Palmer, Esq.
Henry Cavendish, Esq.	The Lord Viscount Palmerston, M. P.
Rich. Clark, Esq. Chamb. of Lond.	Edward Parry, Esq.
Sir John Colpoys, K. B.	Right Hon. Thomas Pelham, M. P.
John Craufurd, Esq.	John Penn, Esq.
The Duke of Devonshire, K. G.	William Morton Pitt, Esq. M. P.
Andrew Douglas, Esq.	Sir James Pulteney, Bart. M. P.
The Lord Bishop of Durham.	Sir John Buchanan Riddell, Bart.
The Earl of Egremont.	Count Rumford.
George Ellis, Esq. M. P.	Sir John Sinclair, Bart. M. P.
Joseph Grote, Esq.	Lord Somerville.
Sir Robert Bateson Harvey, Bart.	John Spalding, Esq. M. P.
Sir John Cox Hippeley, Bart.	The Earl Spencer, K. G.
Henry Hoare, Esq.	Sir George Staunton, Bart.
Lord Hobart.	John Sullivan, Esq.
Lord Holland.	Richard Joseph Sullivan, Esq.
Henry Hope, Esq.	Lord Teignmouth.
Thomas Hope, Esq.	John Thomson, Esq.
Lord Keith, K. B.	Samuel Thornton, Esq. M. P.
William Lushington, Esq. M. P.	Henry Thornton, Esq. M. P.
Sir John Macpherson, Bart. M. P.	George Vansittart, Esq. M. P.
William Manning, Esq. M. P.	William Wilberforce, Esq. M. P.
The Earl of Mansfield.	The Earl of Winchelsea.
The Earl of Morton, K. T.	Hon. James Stuart Wortley, M. P.
Lord Ossulston.	Sir William Young, Bart. M. P.

The following proprietors have been elected as the first managers of the Institution.

For three years: The Earl Spencer; Count Rumford; Richard Clarke, Esq.—For two years: The Earl of Egremont; Right Hon. Sir Joseph Banks; Rich. Joseph Sullivan, Esq.—For one year: The Earl of Morton; the Right Hon. Thomas Pelham; Thomas Bernard, Esq.

At a meeting of the Managers held on the 9th of March, it was resolved, among other things, That the Earl of Morton, the Earl Spencer, Sir Joseph Banks, and Mr. Pelham, should be requested to lay the Proposals for forming the Institution before his Majesty and the Royal Family, and before his Majesty's Ministers and the Great Officers of State;—and, That the Proposals for forming the Institution be laid before the Members of both Houses of Parliament, and also before the Members of his Majesty's Most Honourable Privy Council, and the Twelve Judges.

COW-POX.

WE have already given an account of Drs. Jenner and Pearson's publications on the cow-pox, which tended to establish the important fact, that those who have had that disease, which never proves fatal, and which may always be so managed as never to disfigure the patient, are not capable of afterwards taking the small-pox infection—a fact which, if properly followed up, promises fair to extirpate the latter disease, to which more have fallen victims than to the pestilence itself. Drs. Pearson, Jenner, and Woodville, with a zeal that does them great honour, have since bestowed much attention and labour in ascertaining, by proper trials, how far it is prudent to persevere in substituting a disease that has hitherto appeared no way dangerous, for one that so often proves mortal; and, we are happy to add, with a success equal to the most sanguine expectations that could have been formed: in consequence of which, the following circular letter has been addressed to the gentlemen of the faculty:

Sir,

Leicester Square, March 12, 1799.

I hope you will pardon me for taking the liberty to inform you, by way of additional evidence to the testimonies I have published on the subject of the cow-pox, that upwards of one hundred and sixty patients, from two weeks to forty years of age, principally infants, have been inoculated since the twentieth of January last by Dr. Woodville and myself separately.—I shall at present only communicate the following observations:

1. Not one mortal case occurred.—2. Not one of the patients was considered to be dangerously ill.—3. Although the extreme cases of the severe kind which ordinarily occur in the same number of cases in the inoculated small-pox did not occur in the above practice, and although many of the patients were even more slightly disordered constitutionally, yet the whole amount of the constitutional illness seemed to be as great as in the same number of patients in the inoculated

lated small-pox.—4. None of the patients, namely, above sixty, hitherto inoculated for the small-pox, subsequently to the vaccine disease, took the infection.—5. One of the most important facts is, that the local affection in the inoculated part, on the whole, was less considerable, and of shorter duration than in the inoculated small-pox.—6. In many of the cases eruptions on the body appeared, some of which could not be distinguished from the small-pox.

I have sent the matter of the cow-pox pustule on the thread inclosed, in order, if you approve of the inquiry, to inoculate with it; and I entreat you to favour me with the result of your trials: but I must trouble you to apply the test of inoculating with variolous matter subsequently to the vaccine disorder.

I have the honour to be, &c. &c. &c.

G. PEARSON.

P. S. I am happy to be able to state, that at Berkeley Dr. Jenner has continued his trials of inoculation with vaccine matter, sent from London, with good success.—I should have given you a more circumstantial account of the cases here alluded to, but I think it unnecessary, as Dr. Woodville has a pamphlet in the press on the subject.

THE NEW INSECT.

IN our last we informed our readers that a new insect had appeared within these few years in this country, which threatens the entire destruction of all our apple-trees, if means be not generally followed for extirpating it. In the hurry of the press a material ingredient was omitted in Mr. Forsyth's recipe: we therefore reprint it more correctly.

R. To 100 gallons of human urine and 1 bushel of lime add cow-dung to bring it to the consistence of paint. With this composition anoint the trees. The present is the proper season for applying it. If the white efflorescence-like substance in which the insects are lodged has made its appearance, it should previously be brushed off.

THE
PHILOSOPHICAL MAGAZINE.

APRIL 1799.

I. *Observations on Living Animals found inclosed in Stones and other solid Substances.* By F. W. A. MURHARD.
From Magazin für das neueste aus der Physik. Vol. XI.

OF living animals being found inclosed in solid masses, I have met with no mention in the works of the ancients. Martial, indeed, in one of his epigrams, speaks of insects inclosed in amber; but these animals were dead, and therefore do not belong to this subject. As far as I know, Fulgos* is the first author who makes mention of a living toad being found inclosed in a stone. He wrote about the beginning of the sixteenth century; and the circumstance took place in the village of Meudon in Italy, in the time of Pope Martin V. He was informed by a stone-cutter that there was nothing surprising in it, as such phenomena had often occurred to himself. Agricola, who lived afterwards, speaks of poisonous frogs being found in stones, but which soon died when exposed for a short while to the air. Aldrovandi† also speaks of marble in which these animals were found

* See his work *De Mirabilibus*. Mediol. 1509, fol. and Antwerp. 1565.8, in the chapter *De avibus animalibusque aliis admirandis*.

† Aldrovandi *De Testaceis*, p. 81.

alive. Ray* at first doubted the truth of these relations; but his doubts were soon removed by the undubitable testimony of eye-witnesses. Accounts of a similar kind may be found in Francisci's *Theatre of Various Curiosities*, printed at Nuremberg in 1671†. The author there speaks of toads, crabs, serpents and shell-fish found in stones; but it is very evident that he confounds these with petrifications.

Lloyd, in the third letter at the end of his *Lithophylaciæ Britannici Ichnographia*‡, says, he was informed by Dr. Richardson that he had found a living toad inclosed in a solid rock. Dr. Bradley§ mentions a fact of the like kind, having been witness to a toad being found in the trunk of a large oak. We are told in the History of the Academy of Sciences of Paris for the year 1719, that a toad was found inclosed in an elm as thick as a man's body. As soon as the trunk was cleft the animal dropped out, and no opening could be discovered through which it had got in to the heart of the wood. A similar circumstance is mentioned in the same work for 1731, viz. of a toad being found in an oak at least eighty or a hundred years old||.

Labat, in his Travels through Spain and Italy¶, gives a very minute description of a kind of shell-fish found in stones fished up from the sea in the territories of Civita Vecchia, and which were eaten by the inhabitants. "While walking," says he, "on the coast of Bichiere, I had the pleasure of seeing fished up several sea dates (*dattoli di mare*) which are produced and grow in certain stones of a some-

* Synopsis Animal. Quadruped. p. 21.

† Der lustigen Schau-Bühne vielerhand Curiositäten 2ter Theile durch Erasmus Francisci. Nuremberg, 1671.8. p. 1109.

‡ Lond. 1698.8, p. 107.

§ A Philosophical Account of the Works of Nature. Lond. 1721. 4to. p. 9 and 120. See also Acta eruditorum. Lip. 1721. p. 370.

|| See also Acta eruditorum. Lip. Suppl. VIII.

¶ Voyages en Espagne et en Italie. Amst. 1731.8. vol. iv. p. 240.

what spongy nature, found in great abundance in the Adriatic Sea, and of which there are some also in the port of Civita Vecchia. These sea dates, which are a kind of muscles, are almost round, pointed at both ends, and consist of two shells which open on one side, and are from one or two to nearly four inches in length. The shell is of the same quality as that of the common muscle, but it is a little browner and less smooth on the outside. The inside has a somewhat silvery appearance. The fish which they contain is white, delicate, fat, and of a very agreeable taste, so that it is a morsel for a cardinal (*un boccone di cardinale*). They are called dates, because the shell which contains the fish has a great resemblance to the dates of Barbary when they are ripe and dried. The stone in which they are inclosed is heavy and pretty solid, though it appears spongy. The cavity which the shell occupies in the stone, and which it exactly fills, touches it on all sides like the best fitted case. Some small ones are not half an inch in length, but others are four inches. When the fishermen had procured a sufficient number of the stones, they placed them on the edge of the quay, and broke them by means of a large hammer. In some they found nothing, but others contained two or three dates. They gave some of them to me, together with fragments of the stone which inclosed them, and on which I made the above observations."

Instances of a similar kind may be found also in various other works. Thus we are told that Charles Hall, a merchant at Eberach, saw a living toad sitting in a stone, upon its being broken. Martin Weinreich * relates a circumstance of the like kind; and John Nardius † says, that he found in a block of marble a living snake. Libavius speaks of vipers and toads found in stones, as does also Cardan. A living

* Commentar. de Monstris, cap. vii. p. 58.

† Joan. Nard. in Ann. 1. noct. gen. 4. p. 266.

toad was found in an oak by Seigne in 1731, and another in a hard stone, at Ecretteville, by Le Prince in 1756*.

A great many particulars relating to this subject have been collected by Guettard. A common toad, two of whose feet were free, and the other two sticking fast in gypsum, so that it was impossible to disengage them without tearing them to pieces, was sent to him by order of the Duke of Orleans. Count Hermann II. of Hatzfeld, told Dr. Sachsen† that he heard a living frog croak in the middle of a stone at his palace of Schellenberg, near Cologne, and that the animal hopped out on the stone bursting of itself. I shall now give a few other instances, of which Guettard makes no mention.

In the year 1733 a living toad was found by J. M. Gräberg in a solid hard block of stone, dug up from a quarry in the parish of Wamblingebo, in Gothland, and which he caused to be broken by the workmen. The colour of the animal was blackish grey, a little spotted on the back, and somewhat fainter on the belly. Its eyes were small and round, and covered by a tender skin or film, under which they seemed to sparkle a little with a colour like that of pale gold. Having touched it on the head with a stick, it contracted its eyes as if it had been asleep: as soon as the stick was removed, it gradually opened them; but moved neither its body nor feet in the least, though he touched it different times. He remarked also that the mouth had no aperture. It was covered with a yellowish skin, which he examined also with the stick, but he was not able to make it

* Instances of the like kind may be found in the following works: *Haller de corp. hum. fabr. et funct.* vol. vii. p. 157; *Avant Coureur*, 15 Sept. 1766; *Cbr. Franc. Paullini in Bufone*, c. 3. *sect.* i. p. 33; *Cbrist. Fr. Garmann in Oolog. curr. diss.* ii. p. 145. § 120; *Nierenberg. Hist. Nat.* lib. vi. c. 13; *D. Bauschius de Aetite*, p. 74; *Euseb. Cbrist. Frankens Historie der Grafschaft Mannsfeld*, Leip. 1723. vol. i. ch. 5; *Lessers Lithotheologie*, Hamburg 1751.8. p. 101 and 112.

† *Memoires sur differens parties des Sciences et des Arts*. Paris 1783.4. vol. iv. p. 615.

open it. Having at last pressed it on the back, a little clear water issued from it behind, upon which it immediately died*. Don Antonio de Ulloa, who with Condamine, Bouguer and Godin, was employed in measuring a degree of the meridian in Peru, saw at Madrid two worms which had been found in the middle of a block of marble by the king of Spain's statuary. Miffon, in his Travels through Italy, speaks of a living crab found in a piece of marble near Tivoli. M. Peyssonnel, physician to the king of France, having employed some workmen to dig a well near his house in Guadaloupe, they found living frogs amidst the strata of the rock. His curiosity being excited by this circumstance, he descended into the well himself, bored into the rock, and brought up alive some green frogs, which had a perfect resemblance to the common ones.

In the Gentleman's Magazine for 1756 mention is made of a living toad found in a block of marble, at an old castle belonging to Lord Tankerville, twelve miles north-west from Alnwick†. T. Whiston relates, that in the year 1743 a stone-cutter named Charlton found near Wisbich, in the Isle of Ely, a living toad inclosed in a piece of marble‡. Being called to the spot, he saw the animal, and the cavity in which it was contained. The latter was somewhat larger than the toad, and had almost the same figure. The animal was of a dark yellow colour; and the solid marble, which inclosed it on all sides, was several inches thick. It seemed to be quite healthy, and by its long confinement had not become meagre. John Malpas also, in the year 1755, found a living toad inclosed in a piece of free-stone at Great Yarmouth§. The hole in which it lay was six inches distant from the corner of the stone. He took it out with a pair of

* Kongl. Swenska Vetenskaps Academiens handlingar för år 1741. p. 248.

† Gentleman's Magazine, 1756, p. 74.

‡ Ibid. May 1756, p. 240.

§ See Gentleman's Magazine, loc. cit.

compasses, but in doing so happened to hurt it. When he placed it on the ground it however crept about, but died in the course of an hour. It had a yellow stripe over the back, the colour of which became changed after it was dead. No crack or cleft could be discovered in the stone. The inside of the cavity was smooth, and looked as if it had been polished.

M. Gerhard, at Padenburg, in the county of Mansfeld, saw likewise a living toad inclosed in a stone. The cavity in which it lay seemed exactly fitted to the size of the animal, but was exceedingly smooth in the inside. No opening could be observed through which it was possible for it to have got into the stone. After some search, however, a hole was discovered at the surface of the earth, which extended to the depth of twelve toises; but ceased at the distance of thirteen inches above the cavity that contained the toad. M. Gerhard considers it as very probable that this aperture had formerly extended to the cavity, into which the egg of a toad might have been conveyed by water; and that the opening must afterwards have been closed up near the cavity. The toad, however, must have remained long in this state; for such apertures do not close up soon, and a long time is required for the petrification of earthy particles*.

M. le Cat †, who relates many instances of the like kind, examines the possibility of them, and the causes of such phenomena. Some philosophers have been of opinion, that the eggs of these animals, created by the Supreme Being at the beginning of the world, and floating about on the watery expanse, have since that time been inclosed in the interior parts of the rocks. But M. le Cat contradicts this opinion by remarking that the creation of an egg is not sufficient, and that it must be hatched in order to produce a living creature. He considers it also as impossible that such ani-

* See Nouveaux Memoires de l'Acad. des Sciences et Belles Lettres de Prusse pour l'année 1782. Berlin 1784, 4to. p. 13.

† In Du Lac Melanges d'Histoire Naturelle, vol. iv. p. 615.

imals can be of the same antiquity as the stones or substances in which they are found. The age of the oldest men, says he, never exceeded 169 years; and what is the life of an insect when compared with that of man? Even if we suppose that the moderation of these animals, and their being exposed to very little motion, had caused their growth and the periods of their life to be extended in an uncommon degree; and though their want of air, or rather their being preserved and defended from the manifold impressions of that corrupted element, had contributed a great deal to their support, the prolongation of life thence arising could not exceed so very much their natural and usual existence. M. le Cat rather thinks that a hatched egg, in all the cases mentioned, may have fallen by chance into some small cavity, where it was secured from petrification till its substance acquired sufficient strength. He here remarks that eggs, when rubbed over with varnish so as to be defended from the effects of the air, may be preserved fruitful for years; and he therefore believes, on good grounds, that an egg so secured in the centre of a rock might retain its activity for some thousands of years, and even that it would be impossible for it to be hatched till it had been exposed to a very high degree of often renewed or long continued heat. According to M. le Cat's opinion it is the egg which is of great antiquity, and not the animal. I shall here observe that nature, when allowed peace and rest, does not require so much time as is generally believed in order to produce minerals. Of the truth of this remark I am fully convinced, since I saw in the museum at Göttingen the step of a ladder found on clearing the gallery of a mine in Rammelsberg, abandoned at most about 100 years before, and which in the course of that period had been encrusted with selenite seven inches in thickness. Nay we have instances of ore having grown up in a much shorter time*.

* See *Ulloas Nachricht von America*, vol. ii. p. 14, and *Tiebras Erfahrungen vom Innern der Geburgen*, p. 53, tab. 4, no. 4.

I must observe also, that most of the animals found in this manner were of the amphibious kind, and request the reader to reflect on the habits, nature and mode of living peculiar to that class. Caldesi relates, that tortoises can endure hunger for half a year; and numberless instances might be produced of their strong and tough nature.

I shall not enlarge farther on this subject at present, as I mean at some future period to communicate my ideas to the public in a more connected manner, and to give as complete a theory on it as possible. I flatter myself that I am the more qualified for this task, as many have written on these phenomena and formed conjectures without having ever seen one instance, while I have been an eye witness of some of the latest. In a quarry not far from Cassel, between that city and the palace of Freyenhagen, I found three toads together in a pretty large block of free-stone*. I remember, also, that, when a boy, our house at Cassel being under repair, and the old plaster pulled down, several toads were found between it and the stone wall†.

At a period like the present, when so many things are made the subject of experiment, when every one endeavours to tread in the footsteps of a Bacon and a Newton, and, instead of being contented with surveying Nature in her private recesses and carefully watching her progress, compels her as it were to labour and make known her secrets, I am much astonished that she has not been put to the proof in this respect long ago. Such experiments, without which all theory must ever remain mere hypotheses, and can never amount to demonstration, would require little or no expence. Nothing would be necessary but to make a deep hole in a stone; to inclose some animal in it, such for example as a

* See Diff. Academicor. Institut. Bonon. (interp. Beccario) op. Benedict. XIV. P. M. de Sevor. Dei beatificat. l. iv. p. 1. p. 328; and Beccarius in Commentar. Instit. Bonon. tom. ii. p. 1. p. 323.

† A full account of this circumstance, which I transmitted to M. Kastner, may be found in the *Gottingisch. Anzeig.* for 1796.

toad, and to prevent the air from penetrating to it: or eggs only might at first be put into the stone. It would, however, be attended with most advantage if several experiments were made at the same time, in order that the state of the animals might be examined at different periods. Such experiments, and careful observation of the nature and economy of these animals, could alone lead to any certain conclusion respecting a circumstance so abstruse, which, at present, seems to surpass the powers of our comprehension.

II. *Observations on Snow and Rain; their Influence on Vegetation, and their Combination with Oxygen.* By J. H. HASSENFRATZ. From *Journal de L'Ecole Polytechnique*, P. IV.

ALL those who inhabit parts of the earth exposed to snow, agree in considering this meteor as one of the means employed by nature to give to plants more strength, and to make them expand with more vigour. Several even are persuaded that winters which produce no snow presage a bad harvest and a feeble state of vegetation; and they ascribe its influence to the salts which they say exist in that congealed water. Snow collected in large masses, melted and evaporated in earthen vessels, having left no residuum, has made this supposition be considered as a mere chimera; and, in consequence of reasoning carried too far, some have been induced to deny that snow has any influence at all on vegetation.

In phenomena transmitted through successive generations, we must distinguish the results of observation from the explanations some have attempted to give of them. There are phenomena, indeed, the whole of which present themselves to our senses in their full force, and which can leave no doubt in the mind of the least attentive observer; but there are others which exhibit only a few traces that cannot be dis-

distinguished, unless by particular instruments, or after a series of observations often repeated. When these traces have been observed by a great number of individuals, for several generations, however incorrectly transmitted, and however obscure may be the tradition, the philosopher must beware of deciding too rashly. The greater the number of observers, the more perfect is the uniformity of their opinions respecting the phenomenon, and the more careful ought people to be in their discussions before they venture to contradict them.

The influence of snow on vegetation has been subjected to the examination of too many observers, to allow us to believe it possible that there could be so great an uniformity in their opinions, were not the effects really such as are supposed. In this memoir, then, I shall examine these effects; I shall endeavour to explain the cause of them, and shall enquire what relation there is between the explanation given long ago by farmers and a more accurate analysis of snow.

That, after a very cold and very severe winter, vegetation is stronger and more active in proportion as plants have been covered with a greater depth of snow is a certain fact, proved by the result of the experience of every one engaged in agriculture. The cause is simple and natural. All plants are capable of supporting cold in a less or a greater degree; there are some which cannot be exposed to the temperature of melting ice without perishing, and there are others on which the most intense cold produces no alteration. Each plant then has certain limits to its resistance of cold; a certain temperature beyond which it cannot be exposed to it without the danger of being frozen and destroyed. Several plants exposed to a temperature nearly equal to that which must congeal them do not perish, but, by the sharpness of the cold which they experience, contract a languishing disease, the effects of which they feel during the whole course of their existence.

If we expose to the action of great cold a series of plants
capable

capable of supporting different degrees of it, there will perish in that series a greater number in proportion as the cold has been greater; but if, by means of a covering, we intercept the cold, and prevent the plants from being exposed to a diminution of heat as great as that which exists without, several plants which would otherwise have perished will be preserved; several of those which would have been diseased will be healthy and vigorous, and their number will be greater in proportion as the covering has intercepted a greater degree of cold.

The earth has a heat accumulated in its interior parts: this heat is perceived in all subterranean places of sufficient depth to prevent the external cold or heat from penetrating thither. This temperature is equal to 13° on the decimal scale of the mercurial thermometer (55.4 Fahr.). Snow is a bad conductor of heat; cold penetrates it with difficulty, and its temperature when it melts is zero. When the surface of the earth is covered to a considerable depth with snow, the cold of the atmosphere, in contact with it, tends to cool its mass; and the internal heat of the earth tends to warm it. Through the mass of snow there is then a contest of heat and cold, the usual result of which is to melt a portion of the snow, and to carry to zero the temperature of the middle, in which the plants are situated.

Thus snow has the property of keeping the plants which it covers at the temperature of melting ice; of preserving them from the influence of a greater cold; of supplying them with continual moisture; of preventing a great number from perishing, and still more from languishing; and, consequently, of giving more strength and vigour to vegetables than they would have obtained had they not been covered with snow. It appears then that we may explain a part of the influence which snow has upon vegetation, without having recourse to the salts or nitre which it is said to contain, and which analysis and experiments have proved do not exist.

The explanation of the influence of snow by the continual humidity it supplies to plants, is the result of observations which cannot have escaped intelligent farmers in all ages ; but a knowledge of the influence it has by being a bad conductor of heat, is the consequence of experiments recently made on caloric. The ancients had neither a series of facts nor instruments proper for such researches. They observed, that the atmosphere rusted metals in the same manner as acids ; from which they concluded, that the air contained an acid. They remarked, that nitre was formed spontaneously on calcareous masses ; from which they concluded, that the acid of the atmosphere was a nitre : and this conclusion was not far from the truth, since the latest experiments, and most remarkable discoveries which have contributed in the highest degree to the rapid progress of physics, have proved that the air is formed of two elements, which enter into the composition of the nitric acid, viz. oxygen and azot. Let us acknowledge, therefore, that the philosophers who preceded us possessed no little acuteness and sagacity to be able to discover, so long ago, by the accumulation of several indirect experiments, what the most accurate analysis demonstrates at present.

If snow possessed only the property of preserving vegetables, and of preventing them from perishing by the severity of the cold, it is not at all probable that the ancient philosophers would have considered it as depositing on the earth nitrous salts, as they might have ascertained, by a very simple experiment, that it contains none of that salt ; for they did not ascribe the same property to rain-water, but they remarked that snow burnt the skin in the manner of acids, as well as other bodies immersed in it. Being induced to conclude that there was nitre in the air, it was natural that they should ascribe to this nitre the burning qualities of snow, and consequently its influence on vegetation.

C. Guyton having engaged me to examine the cause of the difference of the effects of snow and rain-water on various

rious substances, I found that they were occasioned by the oxygenation of the snow; and that these effects were to be ascribed to a particular combination of oxygen in this congealed water. I put 1000 grammes of snow in a jar, and 1000 grammes of distilled water in another. I poured into each of the jars an equal quantity of the same solution of turnsole. I placed both the jars in a warm temperature, and, after the snow melted, I remarked that the dye was redder in the snow water than in the distilled water. I repeated this experiment, and with the same result. I put into a jar 1000 grammes of distilled water, and into another 1000 grammes of snow. Into each of the jars I put 6.5 grammes of very pure and clean sulphat of iron. In the first there was precipitated 0.150 grammes of the oxyd of iron, and 0.010 grammes in the other. As the oxyd of iron was precipitated from a solution of the sulphat by oxygen, it thence follows, that the snow contained more oxygen than the distilled water; and it follows from the first experiment, that this quantity of oxygen was considerable enough to redden the tincture of turnsole.

It is fully demonstrated by these two experiments, that snow is oxygenated water, and that it must consequently have on vegetation an action different from that of common ice. The experiments of Dr. Ingenhous, on the germination of seeds, have taught us that the presence and contact of oxygen are absolutely necessary for the plant to expand. They have shewn also that the more abundant the oxygen is the more rapidly will the seeds grow. Most plants suffered to attain to their perfect maturity shed on the earth a part of their seed. These seeds, thus abandoned and exposed to the action of cold, are preserved by the snow which covers them; at the same time that they find in the water, it produces by melting, a portion of oxygen that has a powerful action on the principle of germination, and determines the seeds that would have perished to grow, to expand, and to augment the number of the plants that cover the surface of the earth.

A very

A very considerable number of the plants which we have the art of appropriating for our nourishment and our wants are sown in the months of Vendemiaire, Brumaire, and even Frimaire (end of September to end of December); several of these seeds germinate before the cold commences its action upon them and changes the principle of their life. The snow which covers the rest, acting on the germ by its oxygenation, obliges them to expand and to increase the number of useful plants which the farmer and gardener commit to the earth, and consequently to multiply their productions.

Here then we have three effects of snow upon vegetation, all very different, which contribute each separately to increase, every year, the number of our plants; to give them more vigour, and consequently to multiply our crops. These effects are: 1. To prevent the plants from being attacked by the cold, and from being changed or perishing by its force. 2. To furnish vegetables with continual moisture, which helps them to procure those substances necessary for their nutrition, and to preserve them in a strong healthy state. 3. To cause a greater number of seeds to germinate, and consequently to increase the number of our plants.

Before I conclude, I must mention some important experiments, in regard to vegetation, which I made on rain-water. Rain-water does not act on tincture of turnsole or on sulphat of iron like snow; from which it would appear that it does not participate in that property which it acquires by oxygenation. Rain-water, however, contains oxygen also; but in a state of solution, and not of combination, as in snow; for under an exhausted receiver rain-water suffers air to escape from it, which contains proportions of oxygen much greater than river water, spring water, and even atmospheric air.

Atmospheric air exposed to the action of phosphorus, without the application of heat, after the method indicated by Berthollet, is diminished in its bulk 0.20; that is to say, the phosphorus takes from the azot 20 parts of oxygen in

100 parts of atmospheric air. Air drawn from the water of the Seine, tried by the same eudiometer, gave the same diminution. Air drawn from rain water was, on the other hand, diminished by phosphorus from 0.32 to 0.40. As the mean of a great number of experiments was 0.35, it thence follows that the proportion of oxygen in the air obtained from rain water, newly fallen, is greater and more considerable than that contained in atmospheric air, and in the air of other water.

Since rain water thus differs from common water by the oxygen it holds in solution, and since oxygen has an influence on germination, and even on vegetation, as is proved by the experiments of Ingenhous and Senebier, it is natural to ascribe to it a part of the peculiar action which rain has on the vegetation of plants different from that of other water with which they are watered.

III. *On the Component Parts of Iron-stones, and how these in the manufacturing affect the Quality of Crude Iron.*
By Mr. DAVID MUSHET, of the Clyde Iron Works. Communicated by the Author.

[Continued from page 210.]

HAVING in the former part of this paper stated the average loss which the various natures of iron-stones sustain when exposed to torrefaction in external air, I shall now simply state the quantity of oxygen which the various classes are apt to imbibe when exposed to a high temperature, after those volatile mixtures capable of assuming the gaseous state by the combination of caloric have been expelled.

The facility with which iron-stones become oxydated is entirely dependent upon the nature of the mixture constituting fusibility or otherwise: so that were argillaceous, calcareous, and siliceous iron-stones, previously de-oxygenated, exposed to the same degree of heat—a degree capable of oxydating their iron—the result would be, that the quantity of oxygen combined would be in a relative proportion to the fusibility

fusibility of the mixtures, for a determinate space of time. The argillaceous iron-stone would be found in a given time to have gained least; the calcareous a larger portion; while the siliceous, containing an assemblage of mixture fusible at a degree of heat in which the former would remain unchanged, will be found to have gained the greatest weight; but if exposed to an high temperature for a sufficient length of time, the oxygen absorbed will be in an exact proportion to the iron contained in the stone; only, the siliceous iron-stones arrive soonest at a high pitch of combination. In the course of many experiments I have found the following proportions to be nearly just, when the quantity of iron contained in the respective stones was nearly analogous.

Argillaceous iron-stone, which has yielded me 38 per cent. in the assay-furnace, first distilled and afterwards carefully de-oxygenated, increased in weight, during an exposure to ignited gas for 8 hours in the bottom of a deep crucible, 22 per cent.

Calcareous iron-stone, which afforded a similar quantity of metal, and which was subjected to the same train of preparation, to dispel its volatile mixtures, and unfix its oxygen, gained in weight nearly 23 per cent.

Siliceous iron-stones, containing from 36 to 38 parts of iron in 100, treated in the same manner, afforded me instances of an accumulation of weight equal to 24 to 25 per cent.

In order more particularly to illustrate the double phenomenon of iron-stones first losing and then gaining weight, I shall insert the treatment of one particular stone of each class; from which a positive judgment may be formed of the general operation, and results, peculiar to each.

1. There were introduced into an iron test some pieces of argillaceous iron-stones, weighing - - 1750 grs.

After being exposed to a bright red heat for 8 hours, and then allowed to cool, they weighed 1160

Lost in simple distillation - - - 590 grs.

Equal to 33.6 per cent. Specific gravity in this state 2,52150.

The stone had now assumed a claret colour, and was possessed of regular internal fibres, adhesive to the tongue, obedient to the magnet, and exhibiting every property peculiar to excellent iron-stone.

I returned the residue, which, as above, weighed 1160 grs. and exposed it in an open crucible for 4 hours to an increasing heat till a slight degree of fusion was perceived to take place. This was indicated by the angles of the pieces becoming rounded, and swelling a little in bulk—When cool they were found slightly porous, and weighed 1309

Increased in weight by the combination of oxygen - - - - 149 grs.

Equal to 12.8 per cent. Specific gravity in this state 3.3636.

The fracture of the pieces now wore a semi-vitrified appearance, of a dark blue colour, refractory to part, inadhesive to the tongue, unmagnetic, but much more metallic and ponderous. A calcareous iron-stone treated after the same manner, of which I also used small pieces, weighing - - - - 1750 grs. which had yielded a similar product in iron in the assay-furnace with the former, when cool weighed - - - - 1090

Lost in simple distillation equal to 37.7 per cent. - - - - 660 grs.

The fracture of this iron-stone was now of a bright brown colour, streaked with lime, faintly marked with internal fibre, less tenacious to the tongue than the former class, but equally obedient to the magnet.

The residue, weighing as above - - 1090 grs.
 was returned to the furnace, and exposed in
 the bottom of a deep crucible, till such time as
 a slight indication of fusion was observed;
 when cooled, the pieces weighed - - 1235

Gained in weight by the fixation of oxygen
 equal to 13.3 per cent. - - - 145 grs.

In its present state this iron-stone, in point of colour,
 resembled the former.

Its fracture, however, was smoother, and more vitrified,
 equally destitute of tenacity to the tongue, and obedience
 to the magnet.

3. An iron-stone, which contained a large proportion of
 sand, was exposed under similar circumstances to the same
 degree of heat—Quantity used weighed also - 1750 grs.

When properly torrefied, weighed - - 1248

Lost in simple distillation equal to 28.6 per
 cent. - - - 502 grs.

The appearance which this stone had assumed was of a
 reddish, small, granulated fracture, considerably magnetic,
 but scarcely possessing any degree of adhesion to the tongue.

The residue, weighing as above - - 1248 grs.
 was exposed to an equal degree of heat with
 the former classes, by which the stone suf-
 fered throughout a slight degree of fusion—
 when cool, the connected mass weighed - 1431

Gained in weight by the combination of oxy-
 gen equal to 14.6 - - - 183

The colour of the stone was now changed to a black, vi-
 trescent, slightly porous mass, hard and refractory. I have
 not given the specific gravities of the two last natures of
 stones: iron-stones containing equal portions of iron, in
 similar states of preparation, vary little in their specific gra-
 vities.

It will no doubt be observed, that the increase of weight in these statements tally not with the sums formerly given: the amounts there adduced are results from iron-stones which had been previously deprived of most of their oxygen; but in these, the extra quantity of oxygen taken up by the stone is only given, forming an aggregate, with the original existing quantity, as shall hereafter be shown, nearly corresponding to the sums first given.

From these experiments, singled out to convey a just idea of the changes to which iron-stone may be subjected, it becomes obvious, that all the varieties of iron-stone are capable of decomposing atmospheric air at a certain temperature, and of fixing a portion of its oxygen, whereby weight is gained, by each, nearly equal to 1-8th of its original quantity.

It must also from this appear obvious, that the burning of iron-stone is an operation—though hitherto conducted by chance, exposed to all weathers—of the greatest nicety, and consequence to the certain and economical manufacture of cast-iron; wherein a small addition of fuel, by exciting a high temperature, exposes the iron to the combination of a hurtful principle, in quantity (as will hereafter be shown) almost equal to what the metal was originally precipitated in. The extra proportion of fuel, therefore, requisite under circumstances where a severe mode of torrefaction is either universally adopted, or where it is frequently the result of inattention and want of skill, though as yet unascertained upon a large scale, must be very considerable.

I look upon it therefore to be a great desideratum in the preparation of iron-stone, to contrive a mode which would unite certainty and economy; a mode which would either de-oxygenate the ore unexposed to external air, or which would dissipate its volatile mixtures exposed to air, with a degree of certainty which, with a small share of attention, would preclude the possibility of the metal attracting more oxygen.

In the present mode of preparing iron-stones, too much is left to chance and the discretion of subordinate workmen. The surface of the piles, being always in contact with the open air, is frequently exposed to perforations from winds, especially in those parts where the layer of ignited coals comes in contact with the current: a hollow space is soon formed; the fuel, by means of the fresh air continually pouring in, becomes ignited to whiteness; the surrounding stone is immediately fused: should this aperture be joined by a similar communication from opposite sides of the fire, a degree of heat will be excited beyond what could have been conceived possible in this mode of burning, and oxygen be combined with a mass of stone in such an high proportion as to form a very considerable part of the whole weight. This is an accident which will take place even where order, regularity and experience are conspicuous: were it possible to avoid it by torrefying the iron-stone in that just temperature which has been formerly demonstrated as the most proper, uniting at same time an equal degree of economy, it would contribute greatly to reduce to certainty and rule the operations of the smelting-furnace.

The extreme of fusing the materials, and combining the iron with an extra portion of oxygen, is not the only evil which an accurate mode of torrefaction would avoid: the same train of casualty often affords a considerable portion of the stone not enough prepared, and some quite untouched by the fire. The effects produced by iron-stone in this state are exactly similar to those experienced in the former, arising from the same cause, but existing as the result of two opposite extremes.

I confess it is much easier to point out the faults of an established mode of practice, than to substitute one, which, though it might unite some superior advantages, yet might not combine an equal number upon an extended scale. I have frequently considered the subject, and have as often been impressed with the truth of its importance in the ma-

nufacturing

manufacturing of iron. At some future period I may submit to the manufacturers of iron a double method of preparing iron-stones for the blast-furnace; in which, certainty of operation would be obtained, and in the end most probably a degree of economy insured equal to that of the present mode.

I would effect this by exposing the iron-stone stratified with a small proportion of coals, in simply constructed ovens, entirely covered on the top, except a few small funnels to carry off the smoke and disengaged vapours; the ignition to be occasioned by a current of flame passing under a flue in the bottom of the furnace, and conveying combustion to the sub-stratified coals. As this operation could be conducted to a physical certainty by means of damping the furnace instantaneously, as soon as the vapour, &c. had ceased, or as soon as complete ignition had pervaded the contents, (the duration to be determined by the nature of the iron-stone,) the results in this case could at all times be depended upon, and the present irregular products avoided. A second method of depriving iron-stones of their volatile mixtures would be to expose them to a considerable degree of heat, in contact with the dust of pit-coal coaks—as being the most economical—shut up from the admission of external air. This would not only deprive them of their acid water, &c. but would also unfix most of the oxygen combined with the metal, and afford the iron nearly in a disengaged state. Both these methods, however, at the present time, want the sanction of approving practice, on an extensive scale, to render them useful, or worthy of universal attention.

De-oxygenation of Iron-stones.

This process has been long known in part, and its principles (so far as understood) applied by the metallurgist to deprive the ore, subjected to the assay-furnace, of its oxygen, in order that the metal might become revived. Its operation is however much more extensive than what has hitherto

been conceived; and its results afford the most beautiful and interesting phenomena known in the art of manufacturing iron.

De-oxygenation in the case of iron-stones will admit of being divided into three distinct stages, all of which tend to the same final result.

1. That wherein iron-stone is found to have lost its water of crystallisation and continuity of fracture; to have assumed a greyish white colour, soft and pulverulent; and greatly specifically lighter than formerly, having lost from 2-5ths to 9-20ths of its original weight.

2. That stage wherein the pieces have assumed the state of malleability, and have again become firm and connected; wherein they brighten under the file; and, when subjected to the hammer, under various degrees of heat, receive impressions at pleasure, and draw into shape.

3. That stage wherein, by prolonging cementation, the pieces of iron-stone are found to have passed into the state of steel; possessing all its properties, though difficult to separate from the earthy parts, and preserve its quality; but which may be precipitated from the steelified ore by fusion, in the state of cast-steel, by means of the assay-furnace.

These three distinct stages of de-oxygenation are produced by a continuation of the same cause to which all iron-stones may at pleasure be subjected. With primary ores, richer in iron, the results are more certain, ponderous, and much better suited to operate upon, for the production of good malleable iron and steel: these are almost universally capable of being de-oxygenated, for the production of both these modifications of the metal. I have met with no exception, indeed, but in the case of a few granulated Norwegian ores, a blue speckled Danish ore, a few Russian bog ores, and the Scotch ore of the island of Islay.

In the present paper I shall confine myself to a minute detail of the first stage of de-oxygenation; the second and third stages, as they more immediately belong to the manufacture
of

of iron and steel, shall be fully considered in connection with this curious mode of manufacturing these states of the metal from ores without fusion, which, from its novelty and simplicity, deserves a thorough investigation of operation and principle.

De-oxygenation simply consists in exposing iron-stone or ore, stratified with coaly matter, such as the dust of pit-coal coaks, or the charcoal of wood unexposed to air, at a high temperature. The oxygen contained in the ore is taken up by the charcoal, and passed off in the state of carbonic acid; while the water, carbonic acid, &c. previously existing in the stone, is evaporated by the addition of caloric. In proportion as the ore becomes cleared from these mixtures, the metal becomes more and more revived, approaching however to the state of malleable iron, though still interspersed with the original quantity of earthy parts united in the stone. By increasing the temperature, and continuing its duration, the particles of iron unite, and form themselves into fibres, which, even when cold, may be twisted and bent a little; still however having the original quantity of earthy matter almost invisibly interposed betwixt their interstices. If the heat is urged still further, the iron, now malleable, begins to take up a portion of the carbon from the charcoal, and the metal then commences its change to steel.

During any part of the process, should air come in contact with the ore, by previously destroying the surrounding charcoal, an immediate oxydation of the iron takes effect, proportioned in its increase of weight to the stage of the operation at which it is effected. The ore has then passed into a friable, bulky, and unmetallic state.

In de-oxygenating iron-stones, with an intention of discovering and of establishing an analogy as to the quantity of oxygen contained in the respective classes of stones, I was frequently led to conclude, that argillaceous and calcareous iron-stones contained less oxygen than iron-stones where a

greater proportion of filex predominated. Though by far the greater number of experiments performed on this subject were in favour of such an inference, yet I have at times experienced my arrangement palpably contradicted, without being able to solve the obtruding difficulty. I shall not however despair, in most cases, to reduce to certain invariable inherent properties, and external characteristic forms, the various iron-stones in the manner in which I have arranged them, and consonant to the results obtained from them in the process of manufacture. The utility of such an arrangement, founded upon experiment, must be obvious and striking: it will give certainty and value to the various products of the manufacturer, as it will in the end systematize the manufacture itself, and reduce it to rules guided by principle, and not by the aberration of a false or misinformed judgment.

From many experiments I have made with all the varieties of iron-stones found in this country, I shall subjoin the treatment of one of each class, highly marked with the predominating earths, that an accurate opinion may be formed of the phenomena exhibited in this part of the process.

I. I used a fine argillaceous iron-stone, in small pieces,
weighing - - - - 1750 grs.

After a proper distillation of 8 hours in a degree of heat equal to 30° of Wedgewood, I obtained a fine purple-coloured fibrated iron-stone, which, when cold, weighed - - -

Loss of water, acid, and sulphur, equal to 33·6	
per cent.	590 grs.

The influence which the magnet possessed over this stone was considerable; the adhesion to the tongue was however great.

I next introduced into a proper vessel, in contact with charcoal.

charcoal-duft, fome pieces fractured from the fame original
mafs; they alfo weighed - - - 1750 grs.

After expofure for 14 hours to a degree of
heat equal to 120° of Wedgewood, the iron-ftone,
being carefully feparated from the charcoal and
dried, weighed - - - 1002

Loſs of water, acid, fulphur, and oxygen - 748 grs.

Loſt by fimple diſtillation - 590

Oxygen taken up by the charcoal, equal to
9 parts in 100 - - - 158 grs.

This muſt not, however, be taken as the total meaſure of
oxygen combined with the iron, but only that portion taken
up in the firſt ſtage of the operation; which, as it poſſeſſes
the following properties, fully entitles it to this diſtinction:

1. The iron-ftone, from being firm and compact, poſſeſſing
ſpecific gravity from 3 to 3.5, now becomes comparatively
light, friable, and pulverulent; ſpecific gravity, from 2.1 to
2.5. It now moulders with a ſlight preſſure, and is eaſily
reduced to fine powder of a whitish grey colour, which again
poſſeſſes the following diſtinct properties: It adheres to the
magnet in the greateſt abundance, but not in confuſed
clusters like iron-ftone ſimply torrefied: a manifeſt indi-
cation to become attached in the form of fibres is viſible;
and the quantity taken up is equal in point of bulk to the
effect produced with iron filings.

2. Iron-ftone in this ſtate pulveriſed, when ſtrewed in the
flame of a fire or candle, gives out metallic ſparks, like the
combution of iron-filings when ſtrewed in the ſame man-
ner. When the flame of the blow-pipe is directed upon it,
a conſiderable inflammation takes place, and the metallic
particles again become oxydated.

3. In this ſtate iron-ftones poſſeſs the property of effer-
veſcing violently with the fulphuric and muriatic acids.
The iron and lime are inſtantly diſſolved, without the pro-
duction of heat. This is only peculiar to iron-ftones at this
period

period of de-oxygenation. In no other state either raw or roasted does iron-stone possess this property, unless highly united to lime; but remains undissolved till it has attracted a portion of the oxygen from the acid with which it is in contact.

From these confirming circumstances I conclude, that the particles of metal exist in a highly disengaged state; that they are partially malleable, yet so much combined with oxygen as to be easily precipitated, in fusion, for the production of cast-iron, with a sparing proportion of fuel, and a proper application of solvents. So far, therefore, as this experiment leads us, the practical analysis of this ore may be thus stated:

In the assay-furnace this iron-stone yielded a button of super-carbonated crude iron equal to - - 39.5 parts.

Water, carbonic acid, and sulphur, lost in simple distillation - - - 33.6

Oxygen taken up by the charcoal - 9.0

In the subsequent part of the operation I found that, when the iron-stone had assumed malleability, and brightened under the file, a further quantity of oxygen was taken up, equal to - - - 4.2—13.2

Clay, lime and filix united in the stone - 13.7

100 parts.

The earths I found to be proportioned nearly as follows: Clay 7 parts, calcareous earth 4, filix 2.7 = 13.7.

II. Of a calcareous iron-stone, reduced in the same manner, I operated upon - - - 1750 grs.

After being exposed to a similar distillation,

I found it to weigh - - - 1090

Lost in water, acid, and sulphur, equal to 37.7 per cent. - - - 660 grs.

This iron-stone, when torrefied, exhibited a thin schistus of

of calcareous plates: its fracture also presented calcareous lines running in various directions: its colour was reddish brown, partially fibrated, magnetic, and tenacious to the tongue.

I took of the same, mixed with charcoal dust, 1750 grs. and exposed the vessel to a temperature equally high with the former.

The residue, when carefully separated from the charcoal, washed and dried, weighed

922	
828 grs.	

Lost in simple distillation, as formerly shewn,

660	

Oxygen taken up by the charcoal, equal to

9.6 parts in 100	168 grs.
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In this state the stone was pulverulent, much frittered, and of a darkish grey colour. Its fracture exhibited a number of white spots like madrepore. In many places lime was distinctly perceived: when pulverised, it sparkled in the flame, dissolved rapidly in acids with a violent effervescence, was less magnetic than the former, though possessing a great tendency to adhere in the form of fibres. From this treatment the practical analysis of this stone will stand as follows:

In the assay furnace it yielded, of super-carbonated crude iron,

37.5 parts

Water, acid, and sulphur lost, as formerly shewn,

37.7

Oxygen taken up in the first stage of de-oxygenation

9.6

Afterwards taken up in cementing the iron-stone to render it malleable

4.9—14.5

Clay, lime and silex

10.3

100 parts

By dissolution in acids, I found the earthy parts to be nearly as follows: Lime 5.2—Clay 3.1—Silex 2 = 10.3.

This

This analysis must not, however, be taken as a standard whereby the quantity of iron and earth is to be judged of in calcareous iron-stones in general. The iron-stones of this class contain much less iron than argillaceous or even siliceous iron-stones: 28 to 32 per cent. are products more commonly met with than 37 and upwards; the difference in point of metal being made up in lime and clay. In stating the quantity of oxygen disengaged, I conceived it proper to adduce iron-stones, though of different classes, yet containing nearly the same weight of metal as the quantity either disengaged or absorbed must be in a direct ratio to the existing quantity of iron.

III. I operated with a siliceous iron-stone, weighing
also - - - - - 1750 grs.

composed of small pieces, and exposed for the
same length of time, and to the same degree
of heat as the former classes: the residue
weighed - - - - - 1249

Lost in volatile matter by simple distillation, ———
equal to 28·6 per cent. - - - 501

In its present state the fracture of this iron-
stone was reddish brown, studded with spiculæ
of shining flex, slightly adhesive to the tongue,
and considerably obedient to the magnet.

I next introduced into a crucible, stratified with
charcoal-dust, some pieces of the same mass,
weighing - - - - - 2374 grs.
and exposed them to a degree of heat of equal
intensity with the former; after the pieces were
washed, and carefully dried, they weighed 1343

Amount of water, acid, sulphur, and oxygen
dissipated - - - - - 1031 grs.

Equal to - - - 43·4 parts in 100

Lost in simple distillation as above 28·6

Oxygen taken up - - - 14·8

This iron-stone was frittered, very magnetic, but dissolved less rapidly in acids, and with less effervescence; colour of the fracture light grey, and slightly spongy. The practical analysis of this siliceous iron-stone will therefore stand thus:

Carbonated crude iron obtained in the assay				
furnace	-	-	-	36 parts.
Water, acid, and a considerable portion of				
sulphur	-	-	-	28.6
Oxygen taken up as above	-		14.8	
Further, as will hereafter be shewn				
in making the iron-stone pass into a				
state of malleability	-	-	2.5—17.3	
Earths, viz. flux 9, lime 6, clay 3.1, =				18.1
				<hr/>
				100 parts.

In these experiments I wished to obtain results which would throw light upon the de-oxygenation of iron-stones, with a view to apply them to practice upon an extended scale. I therefore used fresh ore, in order to present nearly the same surface to the action of the heat, and to be able to judge of the results apart from each other. In torrefaction it frequently happens that the stone is reduced too small to enable us, by its subsequent treatment, to form a probable opinion of the tenacity, or otherwise, with which iron-stones hold their oxygen. The difference betwixt returning into the crucible the same pieces deprived of their volatile mixtures, and operating upon fresh ore, cannot be great, especially when they are selected from fragments of the same mass, directed by an intimate acquaintance and thorough knowledge of the qualities indicated by their external forms.

All iron-stones thus exposed to de-oxygenation become more or less saturated with carbon; it forms a union like carbon in steel, and its presence is only ascertained when the iron-stone is dissolved in an acid, by rising to the top, and forming a fine pellicle possessing lustre and various shades of

of colour. I have also at times detected crude carbon in the centre of pieces of ore $1\frac{1}{2}$ inch diameter. To the remainder of this mixture, after the oxygen is taken up, ought to be attributed the natural tendency which most malleable iron made in this process has of becoming red-short.

The average of the results of the principal classes of iron-stones may serve for information on the products obtained, by treating those of equal quantities of mixture. The analysis here furnished is not that of the chemist, or laboratory; but, though the calculations are less rigorous, yet they are sufficient for the manufacturer, and better suited for practical information; as they never once lose sight of their application and effects in the large way of manufacture, and as they have been chiefly effected by an agent, which alone, in the large way, can modify the whole, and procure results consonant to the use and existence of the metal.

From the amount of the experiments here recorded I would be apt to draw this conclusion, that, in general, iron-stones are variously combined with oxygen as to quantity: argillaceous iron-stone, least; calcarous, more; and siliceous iron-stones, most of all.

In the general arrangement which I have made of iron-stones in this and the preceding paper, I wish not to be understood as having comprehended every variety which may exist; new classes may be brought to light, as the progress of discovery and establishment advances. I am at present, however, acquainted with only one exception, which, from its scarcity, I have avoided classing along with those generally used. My experiments also have hitherto been limited as to the nature, so that at the present time I am only enabled to state a few, of its distinguishing properties. This iron-stone is found near to Clough Iron Works, in the county of Lanark. Its appearance is much like a coarse schistous coal; its average thickness is about $1\frac{1}{4}$ inch; possessing a dark sandy fracture, and by no means resembling an ore of iron. The mixture is a union of coal and iron
with

with a small proportion of filex. Its inflammability is great, and it requires a cautious preparation for the blast-furnace. For this purpose it is built upon a thin layer of coals, in piles not exceeding 20 inches, or 2 feet: the coals are kindled in the usual manner, and convey ignition to the incumbent stone. These precautions are absolutely necessary, otherwise the whole stone would be connected in one general mass by fusion.

I exposed of this stone to distillation	-	-	979 grs.
in a bright red heat for 7 hours, during which time a considerable degree of combustion took place, and a black vapour was disengaged; when cool, the residue weighed	-	-	476

Lost, of water, bitumen, and carbon, equal to $51\frac{3}{10}$ per cent.	-	-	-	503 grs.
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In this state, the iron-stone was divided into thin, blue laminæ, of a vitreous nature, and very weakly magnetic.

I next torrefied, of this stone in contact with charcoal-dust,	-	-	-	-	1163 grs.
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When separated, washed, and dried, the residue weighed	-	-	-	-	590
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Loss of mixtures equal to $49\frac{4}{10}$ per cent.	-	573 grs.
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The charcoal was in part consumed, and part of the surface of the ore exposed to contact with air, otherwise it is probable that the loss in de-oxygenation would have been less, by the quantity of carbon contained in the stone, than in torrefying in the open air; where the carbon must infallibly be consumed, and the loss greater. In this state of de-oxygenation this iron-stone possesses the usual properties peculiar to the other varieties. At Clough it is highly esteemed, both as to the quantity and quality of the iron it affords. It is reckoned, in a torrefied state, to yield in the blast-furnace from 55 to 60 per cent. This is easily accounted for, when it is considered, that it loses more than half its weight in torrefaction.

IV. *A short Account of Souffriere in the Island of St. Lucia. From Observations on the Diseases which appeared in the Army there in December 1778, &c. By Dr. ROLLO.*

HAVING in our Number for Feb. laid before our readers an account of the volcano in the island of St. Lucia, from the Swedish Transactions, the following particulars respecting it and the neighbourhood are now inserted, as they tend to make the description of that singular spot more complete.

“Souffriere is a small town situated at the bottom of a bay towards the leeward extremity of the island. It is surrounded by hills covered with trees, the declivities of which, and every part capable of produce, are cultivated, and afford good sugar-cane. This place has its marshes, but not so extensive, or so much to windward as those about Carenage.

“The extremity of the south side of Souffriere Bay runs into two steep hills of a conical figure, which are nearly perpendicular: they are reckoned the highest on the island, and are known by the name of the Sugar-Loaf Hills. From their height and straitness it is impossible to ascend them: we were told it was once attempted by two negroes, but they never returned. They are covered with trees and shrubs, and are the shelter of goats, several of which sometimes descend, and are shot by the natives.

“After you pass the hills to windward of Souffriere, a fine, clear and level country presents itself. From the back of the Sugar-Loaf Hills, and all along the sea-coast, to the distance, we suppose, of from fifteen to twenty miles, this flat or level extends: it is all cultivated and divided into rich estates, affording sugar-cane equal to any in our islands. This beautiful spot is intersected by many rivers of very clear water, and these are conducted by art to the purpose of sugar-making. The rains in this part are less frequent than on any other part of the island; however, they have often a

proportion more than sufficient. The wind here blows from the sea, or nearly so.

“ We cannot finish this description without taking notice of a volcano in the neighbourhood of Souffriere. You pass over one or two small hills to the southward of the town, and, before any mark of the place is perceived, you are sensible of the smell of sulphur. The first thing you discern is a rivulet of black running water, sending forth steams as if nearly boiling. From the prospect of this you soon open on the volcano, which appears in a hollow, surrounded close on every side by hills. There are only two openings; the one we entered, and another almost opposite to it on the north side. In the hollow there are many pits of a black and thick boiling matter, which seems to work with great force. Lava is slowly thrown out; and in the centre of the hollow there is a large mass of it, forming a kind of hill. This we ascended; but were soon obliged to return, from the excessive heat. The lava is a sulphur mixed with a calcareous earth and some saline body. We found small quantities of alum in a perfect state. In the opening, at the north side of the hollow, there is a rivulet of very good water. On stirring the bottom, over which this water runs, we were surprised with feeling it very hot; and on placing a tumbler filled with some of the water close to the bottom of the rivulet, it soon became so hot as not to be touched. The liquid which runs from the pits is strongly impregnated with sulphur, and resembles a good deal the preparation sold in the shops, known by the name of *aqua sulphurata*, or *gas sulphuris*. Before St. Lucia was in our possession, two or three vessels were loaded with the crude sulphur of this volcano, for the use of America.”

V. *Extract of a Report, on the Means to be used for purifying the Air in the Apartments of Sick Persons, made to the Society of Medicine at Brussels. By J. B. VAN MONS.*

THE principal object of the author, in this Report, is to prove that it ought not invariably to be the aim of the physician to repair the loss of a portion of the respirable air in the atmosphere which surrounds the patient; since diseases may occur, such as those of a putrid and inflammatory nature, where an augmentation of the unrespirable part may be beneficial. In such diseases, if air of the common standard be respired, the patient is furnished with such a portion of oxygen as, by increasing animal heat and accelerating circulation, must naturally increase the fever, inflammation and putrefaction, or decomposition of the blood and other humours. A lowered atmosphere, which in health is improper for respiration, must in these states prove salutary, as, by affording less oxygen to the system, it will abate inflammation, check the putrefaction, and diminish other bad symptoms, producing the good effect of what are called cooling medicines. These principles are confirmed beyond a doubt by daily experience*.

“It is,” says this author, “to the salutary effect produced by diffusing through the atmosphere a new portion of unrespirable and of diminishing the respirable air that fumigations have been so long indebted for their being employed as correctors of corrupted air, while those who prescribed them often did so on a very contrary supposition.

“In general I have found the air in the apartments of sick persons to consist of abundance of carbonic acid gas, hydrogen gas, oxygen gas, and azotic gas; sometimes of a

* No facts of this kind are known in England; and from the experience of Dr. Thornton and others, it would seem, that a super-oxygenated air is highly beneficial in putrid diseases, although it be inimical to those of an inflammatory nature. EDIT.

le ammoniacal gas, and a peculiar emanation called contagious miasm, which appears to be a particular combination of hydrogenous carbonic acid gas, holding in solution animal fluids as yet little known. Hydrogen gas almost always holds in solution pure carbon, phosphorus, &c. from which arises the smell of these gases, often so disagreeable. Carbonic acid gas would form a much more considerable part of the atmosphere which surrounds sick persons, were not this continually neutralised and rendered concrete by the ammonia, which is formed and evolved in all diseases where animal substances containing azot are decomposed. It may easily be perceived into what contradiction those have fallen who suppose air to contain at the same time carbonic and ammoniacal gas. The absurdity of exposing in the apartments of the sick, vessels filled with quick-lime, must also be obvious; the inconvenience of which, in all cases, is to keep the patient in a disengaged state, or to return to the air, the ammoniacal gas; the carbonic acid gas, which would otherwise neutralise it, being taken up by the stronger affinity exerted on it by the lime; and, in some cases, to take away the unrespirable gas, the presence of which would be beneficial.

I have ascertained that in a state of health we form by respiration more water, and in a state of disease more carbonic acid. The carbon seems, at a certain temperature, to exercise on the oxygen a stronger attraction than the hydrogen can in the same temperature. Among the principal means for purifying infected air I class vaporised water, which incommodes the patient very little, and takes putrid emanations out of circulation better than the muriatic and acetic acids, or than spirits, being a better solvent than the liquids. When the air is surcharged with ammonia, it would rather let loose into it the carbonic acid gas than the acetic or any other acid. The case in which C. Guy employed with so much success the muriatic acid vapours

was totally different from those which have been the objects of my researches.

The sulphurous acid gas would be useful in some cases to decompose miasmata, by giving up to them a portion of its oxygen; but it leaves behind it an oxyd of sulphur, the smell of which is extremely offensive: the oxygenated muriatic acid gas ought therefore to be preferred.

The gases which in my opinion ought to be employed for augmenting the portion of unrespirable air, are the carbonic acid gas and hydrogen gas. The first ought to be made to pass through water, and the second through oil. By these means you free the carbonic acid gas from that portion of the acid employed to disengage it from the carbonat used, which it carries along with it; and you precipitate from the hydrogen gas the carbon it holds in solution. The oil, after being used some time for this purpose, is found quite black, and converted into empyreumatic or carbonated oil.

VI. *Simple and Easy Method of Cleaning and Whitening Prints or Engravings.* By M. FABBRONI. From *Annali di Chimica*, by BRUGNATELLI. Vol. XIV.

THE methods formerly employed for cleaning engravings consisted in washing them in pure water, or a weak lixivium of pot-ash, or in exposing them a very long time to the dew. Aquafortis has also been sometimes employed. Leys, however, together with the dirt and filth, carried away part of the colour of the engraving, and aquafortis attacked the vegetable fibre of which the paper of the print was composed.

Since the discovery of the oxygenated muriatic acid by Scheele, and the application of its properties, by Berthollet, to the bleaching of cloth, trials have been made of it also for whitening prints and engravings; and Chaptal's experiments on this subject were attended with the best success*.

* For Chaptal's process see Phil. Mag. Vol. II. p. 28.

This process, however, is not so generally followed as it ought to be, chiefly because the preparation of the oxygenated muriatic acid is attended with more trouble than some people will take, and because it is sometimes difficult to procure the acid ready made. This consideration induced M. Fabbroni to make known the following process, which is extremely easy, and may be put in practice by any one.

Half fill a glass bottle with a mixture composed of 1 part of the red oxyd of lead, or minium, and 3 parts of the muriatic acid; and having closed the mouth of the bottle with a glass stopper, put it in a cool place, not exposed to the light. A certain heat will then be produced, which is an indication that new combinations are formed. The oxyd of the lead abandons a considerable portion of its oxygen, which remains combined with the liquor*; the latter then acquires a beautiful gold colour, and assumes the odour of the oxygenated muriatic acid. It holds in solution a small portion of the lead, which does not in the least injure its effect†. It is necessary that the bottle should be of strong glass, and that the stopper be well secured, in order to prevent the elastic vapour which rises from forcing it out. When you employ the liquor thus prepared, take a large pane of glass, and raise a kind of border of white wax around its edge, about two inches in height, and every where equal. By these means you form a sort of trough, into which put the prints, and pour over them a little fresh urine, or water mixed with a portion of ox-gall. At the end of three or four

* Where the oximuriat of pot-ash can be had, the process recommended by Mr. Cruickshank, of Woolwich Hospital, will be found neater than the one here proposed. If the oxygenated muriat of pot-ash be simply added to the muriatic acid, diluted with about an equal bulk of water, the salt is slowly decomposed, and the acid converted into the oxygenated acid. About 1 drachm of the salt, if pure, is found to be sufficient for three ounces of the dilute acid. EDIT.

† If this be a fact, the portion of lead held in solution must be small indeed—otherwise it should be partially revived in a length of time, and produce blackness. EDIT.

days pour off whichever of these liquids you have employed, and supply its place with warm water, which ought to be changed every three or four hours, until it come off perfectly clear. When the matter with which the prints are dirtied is of a resinous nature, which sometimes happens, dip them in a little alcohol : afterwards suffer all the moisture to drain off, and cover the prints with the liquor of the oxygenated muriatic acid made by minium. Place on the edges of the wax another pane of glass, of the same size as that below, in order that you may not be too much incommoded by the smell of the acid ; and you will then plainly see the yellowest prints resume their original whiteness. One or two hours will be sufficient to produce the desired effect. Having then poured off the acid, wash the prints, several times, in pure water, and dry them in the sun.

VII. *Observations on the British Trade with Turkey. From Eton's Survey of the Turkish Empire.*

FORMERLY the trade to Turkey was of considerable importance to this country ; but of late years it had been languishing, and at last dwindled into a state of insignificance, when the present war entirely put a stop to all communication with the ports of the Levant.

As this trade will be again opened when a peace takes place, an investigation of the causes of its decline, and the means to give it its ancient extension, may not, in the mean time, be unimportant to the government and to the merchants of this country.

The causes of its gradual decline are, 1st, The rivalry of other European nations ; 2dly, The diminution of the consumption of our manufactures in Turkey, by the impoverished state of the country ; 3dly, Some branches of trade being got into other channels ; and 4thly, The monopoly of the Levant Company in London.

With respect to the rivalship of other nations, that cause will be considered when I speak of the Levant Company. As to the impoverished state of Turkey, it must affect the trade of other European nations as well as our own; if we are not, therefore, to expect to see it again in that flourishing state in which it was, when there were forty English houses of trade at Aleppo, (at present there is but one,) we may at least expect to have the same proportion of it as we then had; and if we acquire only this, our trade to the Levant will still be a national object. Some branches of trade are got into other channels; this regards principally certain imports from Turkey, and particularly of silk from Aleppo, whence formerly larger quantities of Persian silk came, which is not now brought thither, but the East India Company supply our market cheaper and more abundantly. Considerable quantities of cotton and drugs come from Holland and from Italy, which formerly came direct. This will also be accounted for in the next consideration, the monopoly of the Levant Company.

It is often necessary, and where merchants undertake to open to the country a new branch of trade, and where the expence and risk is great, it is just, to grant them exclusive privileges, or monopolies, for a certain limited time, to prevent others from reaping the harvest they had sown, and to secure their laudable industry as far as possible from risk; but when that risk exists no more, and when they have reaped their harvest over and over again, and have had a full compensation for their risk, their industry, and their expence, the country at large has a right to a participation of the trade. There may, indeed, sometimes exist circumstances of a peculiar nature, which give them a claim to a longer indulgence in their monopoly, particularly where that monopoly is no injurious, but, on the contrary, beneficial to the country in general, (and such is the case of the East India Company;) but in a trade where the merchants have no common stock, and can urge none of the above reasons in defence of their

monopoly; where they cannot prove that any particular loss would accrue to them by abolishing it; where it has operated as a restraint on the trade, confining it to narrow bounds, and giving a decided superiority to their rivals of other nations, to the almost total exclusion of the products and manufactures of their country from that to which their privilege exclusively permits them to trade, ought in common sense such a monopoly to exist? The Levant Company is truly become the *dog in the manger*; it does not operate so much to the profit of the company, as to the loss of the country.

This monopoly is of a singular nature: it has none of the advantages of a common stock, in which many individuals risk small sums, but which in the aggregate amount to a larger capital than any one merchant or set of merchants possess, or would choose to risk; a common stock to which any one may contribute, and which thereby, strictly speaking, ceases to be a monopoly: it is a privilege granted to certain persons only to trade to Turkey, each with his own capital, and for his own particular account and risk, without any assignable reason why they should be preferred to others his majesty's subjects: it has all the disadvantages of other monopolies; it has not one of their advantages.

In speaking thus freely of the company, I solemnly declare that I have no private motive, no rancour against any individual, and no inducement for writing on this subject but the advantage of the country. The few members of the company with whom I am acquainted I personally respect and highly esteem: on this subject they must differ with me; they are bound by oath to support the interests of their body.

The trade of all other nations to Turkey is free, and they have experienced the advantage of being liberated from the fetters of exclusive privileges. Let every obstacle be removed in this country to an equally free commerce, and the superior industry, skill, and riches of our manufacturers, our
traders,

traders, and our navigators, will again restore to us our lost Turkey trade.

It may be said, that at present the Levant Company is not a monopoly, as any one, by paying twenty pounds, may become a member of it. When the trade was already ruined, it was imagined that this regulation was equivalent to laying the trade open, (a proof that government have thought it necessary to abolish the monopoly;) but the bye-laws of the company, and the power to enforce them, were permitted to exist, and these so fetter the trade to new adventurers, that few have found their account in pursuing it, and the trade still remains a monopoly in favour of the old houses.

It will be necessary to pass in review these bye-laws, which have operated so injuriously to the trade in general; and to show how they have gradually effected its total ruin, and the introduction of rivals, who have gotten possession of what we have lost.

By one of the bye-laws, for instance, it was enacted, that all merchandise brought from Turkey, and imported into England, should be the produce of goods exported from England to Turkey. The following are the words of the bye-law:

“ That upon entering goods received in England from Turkey or Egypt, every member shall in like manner subscribe the following affirmation; *videlicet*:

“ I affirm, by the oath I have taken to the Levant Company, that the goods above mentioned are for account of myself, or others free of the said company, or of such as now have their licence to trade, and are beyond the seas; and that the said goods, nor any part of them, are not, to the best of my knowledge, the produce of gold or silver, either in coin or bullion, sent into Turkey; but that the said goods are purchased by merchandise, or monies arising or to arise from the sale of merchandise sent into Turkey or Egypt, from Europe, or from the British settlements in America, on account of freemen of the Levant Company, or such as have their licence to trade, and of which regular entries have been

made

made with the company, or are purchased by freight received in Turkey or Egypt, by ships navigated according to law; which freight is entirely the property of members of the company, or such as have their licence to trade."

And every merchant or factor in Turkey or Egypt is required to make a similar affidavit, on exporting goods from Turkey for England; and to give, on oath, an exact account of every kind of transaction or business, direct and indirect; so that all his affairs become known.

The object of this law is evidently to encourage the exportation of cloth; and when we had no rivals, it produced no bad effects; but it soon produced rivals, and it continued in force till they had nearly got possession of the whole cloth trade. Such a law, indeed, was sufficient to ruin any trade. One house may deal in exports, another in imports; one may combine its Italian with its Turkey trade; another may send vessels for the carrying trade: but if every individual house be obliged to keep an exact register on oath, and under a penalty of 20 per cent. called "a broke," of all its exports and imports, and to balance them exactly, how is such a trade to prosper, where the profits are reduced by the rivalry of foreign nations? This bye-law at length, when it had produced the full effect of its ill tendency, was repealed; but the trade was not revived: so difficult is it to turn back commerce from channels into which it has run.

It will be asked, then, what are the restraints which now lie on the trade?

The subjection to the control of the company; the necessity of making entries with it of all their transactions on oath, and not being able to be concerned in anywise with others not free of the company, or foreigners; the power in the company, for the least violation of their rules, to inflict a penalty of 20 per cent.; the idea of restraint, and the apprehension of violating a solemn oath, have made many determine to trade with Turkey through foreign and circuitous channels, without becoming free of the company: witness
the

the very large quantities of cottons and drugs, &c. which come from Holland and Italy, as the custom-house books prove. This was the case till our trade to Holland and the Mediterranean was stopped by the war, and in that same situation we shall be when a peace takes place.

The drugs, &c. which are imported from Italy, were carried thither from Turkey; they had already given a profit to the Italian factor in Turkey; to the importer, and to the purchaser in Italy, who cleans, afforts, repacks, and often adulterates them; to the commissioner, who purchases them for his correspondent in England; to which add charges, and interest of money for so long a disbursement, which the different people through whose hands the merchandise has gone have all calculated, as well as their profits, double freights, and loading and unloading, &c. &c.

Cottons are imported from Holland, because the company cannot import themselves enough for the consumption; and the reason why they do not is, because the old members, who are under no apprehensions of the bye-laws, find other articles enow to employ their whole capital, and beyond that the trade cannot increase. This is the reason, as will be seen hereafter more fully, why the trade in exports as well as imports is confined within such narrow bounds.

The British merchants in Italy and other foreign countries, not being members of the company, (and to become free of the company they must come to England,) cannot trade with British houses in Turkey; and these, if they will trade to Italy, must trade with foreigners: thus all combinations of the trades are prevented. English vessels in the Mediterranean might often make a voyage to Turkey, instead of lying in an Italian port, and return time enough to take in their cargoes for England.

The great preference given to British vessels in the Mediterranean would assure them an employment whenever they want freights. This carrying or caravan trade is so extensive, that,

that, besides the French, the little state of Ragusa has no less than 400 vessels in it.

Were the masters of ships, their owners, and the English merchants in Italy and Turkey, under no restraint in regard to the Levant Company, people would risk more readily the sending their vessels to the Mediterranean to get employment in this carrying business, and, their speculation in trade being free, they would find means to employ their vessels in the intervals of their being without freights; the masters, owners, and correspondents might combine their own speculations in merchandise with their carrying business, and thus keep them constantly employed. It is the want of these resources to our ships, that prevents English owners from sending their ships into the Mediterranean to seek freights, and prevents the few which do go thither from profiting so much by it as those of other nations, whose houses of trade are nearer, and whose trade is under no restrictions.

Had the Turkey trade in England never been a monopoly, the French would never have got possession of almost all the cloth trade; and the laying it open will be the only means of our coming in again for any considerable share in it. There is a greater demand in Turkey for the light Languedoc cloths, than for any other sort. The Turks clothe their servants twice a year; and the French cloth, made into loose garments, (which last much longer than the tight European dress,) is strong enough for their purpose, and its cheapness causes it to be preferred; poorer people, who form the great body of consumers, buy it also for economical reasons. English broad cloth, called mahoot, (of a light quality, made purposely for the Turkey market,) is only worn by those in easier circumstances. Considerable quantities of cloth have also of late years come to Turkey from Germany.

It is the opinion of many people well acquainted with these matters, that the English manufacturers might make the same sort of cloth as the Languedoc, and as cheap as the French;

French ; but, as long as the Levant Company exists, who is to undertake it? Were the trade laid entirely open, it is probable that all kinds of English manufacturers would send people (called riders) to Turkey to seek for commissions, as they do to all parts of Europe. This practice, though not very agreeable to English merchants, (which however may not be the case in Turkey, as they may find the mediation of merchants necessary,) would greatly increase the vent of English commodities, and these industrious people might possibly be the means of our regaining the cloth trade.

The few merchants who are in the true secret of the Levant trade, can employ in it their whole capital advantageously, and therefore do not seek for new branches, or how to recover old ones which are lost.—This is the great secret.

The French do not get their wool cheaper than we do; the price of labour may be less; but will not superior skill and industry, with larger capitals, compensate this single circumstance against us? Experience in other articles shews it, as in the manufactures of Manchester, Sheffield, and Birmingham.

It is very worthy of attention, that the French cannot make so cheap as we can the same kinds of cloth, which our people bring to the Turkey market; it is not that they cannot make them so fine, for they make in France much finer cloth than that kind of broad cloth made in England purposely for the Turkey market. There is also a coarse strong cloth brought to Turkey from England, called *londras*: these the French cannot make so cheap neither; nor are their shalloons so cheap. In short, there is no sort of woollen stuff made in the two countries, of the same quality, which the English do not sell cheaper than the French. The fact seems to be, that the French invented a kind of cloth more proper for the general consumption of Turkey than that which the English had brought thither; and the English never attempted to follow their example, but continued carrying

rying to the market a sort of cloth, which at last got almost out of use. Whenever the English shall have made and brought to Turkey the same kind of cloth as the French, and cannot afford it so cheap, then with certainty we may conclude that the French have an advantage over us; but till then it ought to be doubted, and certainly it merits the trial; but a fair trial never can be made till the Levant trade is entirely free.

But even supposing that we cannot regain the cloth trade, there are very many other objects worth attending to, and which may be of great national advantage.

The Manchester stuffs would find a great vent in all parts of Turkey. The manufactories of Aleppo and Damascus are almost ruined; and if the Manchester people were to imitate the Turkish patterns of their stuffs, they could certainly afford them cheaper. Imitations of the Surat and Bengal goods of silk and cotton, which are enormously dear, would find also a ready sale in Turkey; and cotton velvets, velverets, &c. Birmingham and Sheffield wares would be articles of importance. The Turks, both in Europe and Asia, have a great partiality for all these kinds of English manufactures, and in general the epithet English is synonymous with excellent.

These articles at present are not attended to; but the masters of ships, who bring out their little ventures to Turkey in a contraband manner, in these kind of things, make great profits; they can, however, bring only small quantities, lest the Levant Company should take umbrage at it. A few of these goods also find their way to Turkey from Italy, but greatly enhanced in their price from the many hands they go through, and therefore this channel does not afford a great vent for them. Linen may likewise be an article of exportation for Turkey. The Turks wear linen of a hard twisted thread, very open and unbleached, which comes mostly from Egypt, and is exceedingly dear, but is the most pleasant kind to wear in hot weather. No European nation
has

has yet undertaken to imitate it ; but it is probable it might be made in Ireland infinitely cheaper than in Egypt : if this was the case, it would be of great importance. The German linens begin to be sold in considerable quantities in Turkey ; but they never will supply the place of the Egyptian, on account of their quality. Vast quantities of the above mentioned articles come from Venice and Germany, where they are dearer, and of worse quality, than those manufactured in England.

Were I to enter into an enumeration of all the English manufactures that could be sold in Turkey, and particularly in the interior parts of Asia, and point out the different ports to which they might be sent, the detail would be too long for a general representation ; but collectively it must be very obvious to every person acquainted but generally with the trade of Turkey, that our exportations to that country must become of great importance in a few years, were the monopoly removed, and the agents of the manufacturers sent to travel through the country, and get certain information of the state of its trade and manufactories.

Salt fish, could the Newfoundland ships, &c. go directly to Turkey as they go to Italy, would be a very important branch.

The East India Company could supply the Turkey market with muslins much cheaper than they are brought by the way of Baffora, of Gidda, and Suez, which trade is entirely in the hands of their servants : the trial has been successfully made ; but the members of the Levant Company have other articles enow in which to invest their whole capitals. Other nations now bring large quantities of muslins to Turkey. British muslins (*i. e.* manufactured in Britain), also sell to considerable profit.

Let all this be mere supposition, is not the object of importance enough to give it a fair trial ? and does not common sense say, that a trade freed from obstacles must flourish more than when clogged with the most unsupportable shackles, or
with

with any shackles at all? May it not be asked, what just right have the members of the Levant Company to lay restraints on this trade by their bye-laws? I have heard this subject discussed in Turkey, where people certainly understand the trade of the country better than in England, and I never heard one plausible reason alleged in favour of the company. Sophistical arguments may be produced in London, which may appear plausible to those who are not informed of the real state of matters in Turkey.

To show what little efforts have been made by the company to extend the trade, and how little they deviate from the footsteps of their forefathers, I will cite two striking instances :

Mr. John Humphrys, of Constantinople, was the first, who, a few years ago, imagined that English shalloons might be sold in Constantinople, and they soon became a very important article for exportation to Turkey. The French have not been able to make them so cheap.

Mr. Peter Took, of Constantinople, only about twenty years ago, discovered that he might buy raw silk from the first hands at Brusa, (the hills behind this city are visible from our merchants houses in Pera,) and thus make his returns direct to England. Before that period, from the first existence of the company, the merchants of Constantinople had always sent their money to Smyrna to be invested in silk, which the Turks and Jews of Smyrna bought at Brusa.

There is a great demand in Turkey for Staffordshire earthen-ware, which would become a very important article of commerce.

Perhaps the greatest importation of British articles into Turkey would be by foreigners, or natives of the Turkish provinces, as is the case in many branches of our commerce, where such restraints on foreigners do not exist; for instance, every one knows that not one-tenth part of our exports to Russia are on account of the Russia Company in London, or of the British Factory in Russia. These articles are sent to

Russia

Russia for account of foreigners settled in Russia, or Russians, and some part for account of our manufacturers. With respect to Germany this is still more the case.

The Levant Company exact a duty on all merchandise exported to and imported from Turkey, besides a consulage in the ports of Turkey on all the exports and imports in British vessels. This consulage is a very heavy burthen on our trade, and particularly when it is considered that some other nations pay none. The following are the words of the company's bye-law :

“ At a general court, &c. the following orders were established as proper and expedient for the support of the company's affairs, and for the government of the trade; and they were confirmed at a general court held 3d of March 1775.

“ It was resolved and ordered, That all goods exported from Turkey or Egypt for Great Britain shall pay three consulages and one-half, or seven in the hundred, according to the rates of the company's tariff, in such species of the grand seignior's coin as his officers receive for customs; which consulage shall be paid, one-half in thirty days, and the other half in sixty days after the departure of the ship, &c.; and the company's treasurers are not to take any notes or obligations for the payments of consulages, but they are to insist upon being paid in money when it is due.

“ That all goods imported, &c. into Great Britain, shall pay one imposition according to the company's rates, &c. except cotton and emery stones, &c.

“ That all goods imported into Turkey or Egypt, from Leghorn, or any other port or ports of Christendom, by British subjects or British ships, for account of foreigners, shall pay a consulage of two in the hundred, &c.

“ That all goods exported from Constantinople, Smyrna, and Aleppo, to Leghorn, or any other foreign port or ports of Christendom, by British subjects, on foreign ships, on ac-

count of British subjects, shall pay a consulage of one in the hundred, &c.

“ That all goods imported into Turkey or Egypt, by strangers, upon British ships, from any foreign port, &c. shall pay two in the hundred, &c. and in like manner exported, two in the hundred, &c.” and several other regulations for the paying of consulage, of lesser importance, which I omit for brevity.

“ April 29th, 1785. It is resolved and ordered, &c.

“ That all goods, excepting raw silk, mohair yarn, and drugs, exported from Turkey and Egypt, in the time of the plague, to Malta, Ancona, Venice, Messina, Leghorn, Genoa, or Marseilles, for the purpose of performing quarantine, and which are to be re-shipped on the same ship for Great Britain or Ireland, shall pay a consulage of two in the hundred only.”

Besides this revenue, the company have for many years received an assistance from government of five thousand pounds a year. All these sums are expended for paying a part of the salary of the ambassadors at Constantinople, the consuls at the several ports in Turkey, the chancellors and drogomans (or interpreters), and for defraying the expences attending visits from the ambassador to the porte, and of the consuls to pashas, besides extraordinary presents made at the first audience of a new ambassador and of a consul; for paying *avantias* (or money extorted by false accusations), and public entries of consuls, which were formerly very costly; and finally, for the expences of the company and its officers at home.

Were our trade put on the same footing as the Russian, the five thousand pounds government now pays, would perhaps more than suffice for all the expences which then would be necessary; and that our trade could be put on the same footing, I suppose nobody will deny. The Russian trade to Turkey is free to every one; there is no tax on it, either
under

under the appellation of consulship or otherwise; no fee is taken at any ambassador's, consul's, or chancellor's office, for documents necessary for the dispatch of trade; no presents are made by consuls to pashas or other officers; no *avania* is submitted to.

A consul at Smyrna only is necessary. Vice-consuls in the other ports would answer every purpose for the protection of trade; and there would be found merchants enow, who would be glad of the office without pay, for the honour of it, which in Turkey is considerable. There is at this day no necessity for consuls living in such great state as they did a few years ago. The foreign ministers at Constantinople have very considerably retrenched their expences.

The power of an ambassador and of a consul in Turkey is very great; it extends even to life and death. By one of the articles of the capitulations (or treaty with the porte) it is stipulated, that in all criminal cases wherein subjects of the porte are not concerned, ambassadors or consuls shall punish the criminal according to the laws of their country. In the Dutch capitulations this is expressed still stronger. As crimes committed in a state are crimes immediately against that state, the cognizance of them belongs to it alone. The sultan delegates his power to the ambassadors and consuls; and if in punishing the criminal they exceed the rule prescribed by the laws of their own country, they are only answerable for their conduct to the sultan; but the sultan takes no cognizance of it, therefore they are without control, and their power is despotic. It is indeed true, that they generally send such offenders home to their country; there have, however, with other nations, been examples where an European has killed a subject of the porte, and justice being demanded the ambassador or consul has put the criminal to death. Should it happen that an Englishman killed a Turk, it would certainly be better that the ambassador or consul should cause him to be hanged by his own people, than that he should deliver him up to the Turks, for justice being demanded,

there is no other alternative; if he escaped, the consequence might be a general massacre; we have lately had an example at Smyrna exactly of this nature, which cost the lives of many hundreds, and caused the European quarter to be reduced to ashes. There is no possibility of sending the criminal home if the populace demand justice.

The company have given also another power to the ambassadors and consuls over merchants, which free traders may not approve of. Their bye-law is: "If any factor or factors shall have any dealings with any person battulated by the lord ambassador, or the consul of any of the scales (ports, Scala Italian) in Turkey, with the advice of the respective factories, such factor or factors shall pay a fine for every offence to the amount of three consulages upon the value of the transaction by or with such battulated person, without appeal, &c." Battulation with them signifies interdiction of all commerce with the person battulated. The intention was to prevent the factors or merchants having dealings with litigious persons of the country; but this power has been abused.

The ambassador formerly had a considerable revenue from protections granted to subjects of the porte, under the title of Baratli, or honorary drogomans; but these protections having been totally disregarded by the present sultan, who without any ceremony has beheaded several persons possessed of them, both that income and that source of constant litigation with the porte are partly done away. It were to be wished that this privilege was wholly abolished. The French several times proposed giving it up, and at a time when it was respected, and lucrative to their ambassadors.

The French also, on the representation of their ambassador, M. de St. Prieste, laid the Levant trade open; the consequence was, that immense quantities of French goods were carried to Turkey by subjects of the porte; but the company at Marseilles found means to get their exclusive privilege renewed; they had suffered, but the country had gained. At
present

present every one has liberty to trade ; and since our fleet has left the Mediterranean, their commerce is revived, and, except the trade to Great Britain be equally free when a peace takes place, we shall have little chance of being able to rival them : but we must not wait till that period arrives to lay our trade open ; it must be done immediately.

As all communication with the Levant by sea is cut off, there remains no resource to our merchants, but to carry on their trade through Russia ; and though this be a circuitous way, it is not by far so expensive as might be imagined. The freights to the Baltic are very low, as half the ships go out empty. The carriage from Riga to Cherson, or Nicolai on the Bog, is mostly by water, and the land carriage in Russia is not one fourth of the price it is in Germany. The expence on cloth would be trifling, and on cheap and bulky goods even would not be equal to the enormous price of insurance paid for armed ships, which run the voyage at present, and which is not equal to the risk ; it is indeed so great, that government should, perhaps, interfere. At Cherson there are good vessels to be found, which in three days may carry the goods to Constantinople at a reasonable freight.

But in order to open such a communication, liberty must be obtained of the emperor of Russia to send merchandize in *transito* (without paying duty) across Russia ; and there is no doubt but that sovereign, who has studied Adam Smith's book on the Wealth of Nations, and who is perfectly acquainted with the principles of commerce and navigation, would see the very great advantage which would accrue to Russia by such a trade, both on account of the sums which would remain in the country for expences of carriage, the employment of a number of people, and also the encouragement it would be to the Russian navigation in the Black Sea ; but he never would *grant* such a privilege to a part of the British nation exclusively, and shut out from it the Russian merchants, who carry on a branch of commerce so advan-

tageous to his empire, nor exclude his own subjects from it. Before this can be done, the Turkey Company must be abolished.

At present a few goods, I am informed, have been sent to Hamburgh, thence to Vienna, and down the Danube, where they are shipped for Constantinople. The freight to Hamburgh is dearer than it is to Riga; the charges across Germany ten times as much as across Russia. At the mouth of the Danube there are only bad Turkish or Greek vessels to be freighted, on which no regular insurance can be made. At Cherson there are some hundreds of vessels, among which many equal those to be found in the ports of other seas, and a reasonable insurance may be made on them by safe underwriters; but the route through Germany does not necessitate an abolition of the Levant Company.

VIII. *Observations on Naples Yellow, and the different Methods of preparing it.* By Professor BECKMANN.

NAPLES yellow, which is also called Neapolitan earth, in Italian *Giallolino*, and in French *Jaune de Naples*, has the appearance of an earth, is of a pale orange-yellow colour, ponderous, granulated, exceedingly friable, does not effloresce, nor become moist when exposed to the air, but when applied to the tongue seems to adhere to it. When reduced to a fine powder, it remains for some time suspended in water, but soon deposits itself at the bottom in the form of a slime. When boiled with water, the water, at least sometimes, is observed to have a somewhat saline taste. It does not effervesce with acids, but is in part dissolved by aqua-regia (*nitro-muriatic acid*). In the fire it emits no sulphureous vapour, is difficult to be fused, and by that operation undergoes no material change, only that its colour becomes somewhat redder. When fused with colourless glass, it gives it a milk-

milk-white colour, a sure proof that it contains no iron; and, with inflammable substances, there is obtained from it a regulus which has the appearance of a mixture of lead and antimony.

This article is brought from Naples for the most part in the form of an earthy crust about three or four lines in thickness, and it sometimes retains the form of the vessel in which it has hardened. It can be procured also as a fine powder, as the colourmen keep it sometimes ready pounded for use.

How long this colour has been an article of trade I will not venture to determine. As far as I know, Pomet is the first druggist who mentions it; but he tells us that it was exceedingly scarce. Kunckel, who has carefully enumerated all the substances proper for colouring glass, and for glazing earthen-ware, does not, as far as I have observed, take any notice of Naples yellow; but if names alone can afford any proof of antiquity, I would assert that this colour was known in Italy at any rate, about the end of the sixteenth century; for Ferrante Imperato*, whose book was first printed in the year 1599, says that “there are two kinds of *giallolino*, one of which is produced from white lead by the first alteration.” This passage seems to allude to the real Naples yellow; but perhaps he only meant the yellow calx (*oxyd*) of lead, or the so called massicot. Respecting the other kind, he gives no

* *Historia naturale*. Venetia, 1672. fol. p. 107: Il giallolino si fa di cerussa nella prima alteratione; imita nel colore il fior di ginestra. Evvi un' altro giallolino, di cui tratteremo tra li smalti e l'impetente. Il minio moderno, o sandice de antichi, si fa dell' istessa cerussa, e giallolino passato in maggior rosseza par la maggior cottura. In the Latin translation printed at Cologne 1695, 4to, this passage can scarcely be known to be the same. *Lib. iv. cap. 42, p. 132*: Flavum e cerussa in prima alteratione efficitur, florem genistæ colore imitatur. Est et aliud flavi coloris genus, quod inter encausta atque dealbationes tractaturi sumus. Minium modernum, vel antiquorum sandyx, ex eadem fit cerussa, et flavo acriori cotione in majorem rubidinem transmigrante. I suspect that the term *giallolino* was used earlier than the pigment to which that name has been exclusively applied.

explanation. But, however this may be, it is certain that no writer ever yet knew properly what the nature of this paint really is. Most of them have considered it as originating from fire, and as a volcanic production of Mount Vesuvius or Mount *Ætna* * ; others have pronounced it to be a natural ochre †. Guettard thought it rather a kind of bole ‡ ; but Pott approached nearest the truth, by asserting it to be an artificial preparation §. Fougereux is entitled to the merit of having proved this, and of having shewn the possibility of preparing it. According to his experiments, Naples yellow will be obtained, if you boil for seven or eight hours, first over a slow and then over a strong fire, a mixture finely pulverised of twelve parts of pure white lead, one part of alum, one part of sal ammoniac, and three parts of diaphoretic antimony || (*white oxyd of antimony by nitre*). But before Fougereux, who may have obtained an account of the process during his Travels through Italy, a more certain process was published in the year 1758, by Giambattista Passeri, in his interesting work on the painting of earthenware¶. The articles to be employed, according to this author, are, “one pound of antimony, a pound and a half of lead, one ounce of *allume di feccia*, and the same quantity

* Among these are Pomet, two writers in the first edition of the *Encyclopedie*, Montamy in *Abhandlung von den Farben zum Porzellan*, Leipzig, 1767, 8vo, p. 266, and the editor of *Dictionnaire portatif de peinture, sculpture et gravure*, 1757, p. 363.

† For example, Hill in his *History of Fossils*, vol. i. p. 55, 66. Gadd also in *Inledning til Sten-Rikets Kænning*. Abo, 1787, 8vo, p. 49, mentions Naples yellow among the calcareous earths mixed with metallic calces.

‡ In *Memoire sur les ocres*, to be found in the *Memoirs of the Academy of Sciences* for the year 1762.

§ *Lithogeognosie*. II. p. 15.

|| In the *Memoirs of the Academy of Sciences* for the year 1766. p. 303.

¶ This paper may be found in *Nuova raccolta d'opuscoli scientifici*. t. iv. 1758. p. 103. Il giallolino, o color d'oro, si fa con una libra di antimonio, una e mezza di piombo, ed un'oncia d'allume di feccia, ed un'altra di sal commune.

of common salt." I am inclined to think that this receipt was not unknown to Fougereux, and that he considered *allume di feccia* to be alum. Professor Leonhardi, a man of very sound learning, has translated this expression by the word alum. I will, however, freely confess, that I consider *allume di feccia* not to mean alum, but salt of tartar, or potash *. Passeri says that the proportions may be varied different ways; and he gives six other receipts, in which he does not mention *allume di feccia*, but only *feccia* †; and this word certainly means *weinbeseu* or winestone (*tartar*). Professor Leonhardi himself seems to confirm this opinion, by saying, that Vairo, professor of chemistry at Naples, has translated "the ashes of wine lees" (*cineres infectorii*) by the words *allume di feccia* ‡.

After

* In the 2nd edition of Macquer's *Chemical Dictionary*, vol. iv. p. 133.

† Page 103. Si avverte, che diversificando le dosi, si diversifica puranco la riuscita del colore ond' è che alcune scuole, o fabbriche hanno avuto colori molto differenti dagli altri, anzi io osservo, che nelle antiche Majoliche ogni pezzo ha tinte differenti, perchè ogni maestro preparava i colori a suo modo, ed eccone alcune differenti dosi. Then follow six different receipts, as above mentioned:—1. Piombo libre sei, antimonio libre quattro, feccia libra una. 2. Piombo libre tre, antimonio libre due, feccia libra una, sale once sei. 3. Piombo libre cinque, antimonio libre quattro, feccia once sei. 5. Piombo libra una e mezza, antimonio libra una, feccia libra una, sale libra una. 6. Piombo libre tre e mezza, antimonio libre due, feccia libra una.

For the sake of the English reader we shall here give a translation of the above six receipts, without pretending to explain the word *feccia*, as we confess we cannot throw more light upon it than Prof. Beckmann has done.—1. Six pounds of lead, four pounds of antimony, and one pound of *feccia*. 2. Three pounds of lead, two pounds of antimony, one pound of *feccia*, and six ounces of salt. 3. Five pounds of lead, four pounds of antimony, and six ounces of *feccia*. 4. Four pounds of lead, two pounds of antimony, and six ounces of *feccia*. 5. One pound and a half of lead, one pound of antimony, one pound of *feccia*, and one pound of salt. 6. Three pounds and a half of lead, two pounds of antimony, and one pound of *feccia*.

‡ In the first part, page 245. One great advantage of the new edition by Professor Leonhardi is, without doubt, the addition of the foreign terms of

After Fougereux's paper was printed, De la Lande published a receipt which he had received from the well-known prince San Severo, and in which lead and antimony only are employed; but no mention is made either of alum, tartar, or any other salt *.

The fixity of this pigment, a property in which lead ochres, when used alone, are deficient, is ascribed by Fougereux to the antimony and alum. The latter, perhaps, may not be necessary, but the addition of the former is indispensable. It is well known that the glass of antimony has a hyacinth colour, and that with red lead and flint it produces glass of a gold colour †.

Artists generally complain that this pigment often fails in its application, because they cannot always procure it of an equal quality. This difference arises in all probability from

of art. As dictionaries, and particularly those of the Italian language, are in general deficient in regard to scientific expressions, it would be doing a great service to the public if some man of learning would collect and explain all those which relate to chemistry and mineralogy. At any rate translators ought to follow the good example set them by M. Leonhardi.

* I shall here give the whole receipt as it stands in the last part of the newest edition of *Voyage en Italie*, par De la Lande. Paris, 1786. 2 vol. 12mo, p. 504: Take lead well calcined and sifted, with a third part of its weight of antimony pounded and sifted also. Mix these substances well together, and sift them again through a piece of silk. Then take large flat earthen dishes, not varnished, cover them with white paper, and spread out the powder upon them to the depth of about two inches. Place these dishes in a potter's furnace, but only at the top, that they may not be exposed to too violent a heat. The reverberation of the flame will be sufficient. The dishes may be taken out at the same time as the earthen-ware, and the substance will then be found hard, and of a yellow colour. It is then pounded on a piece of marble with water, and afterwards dried for use. This is what is called Naples yellow.

† To this subject belong the experiments of Lewis, who, though he carefully examined all those substances which seemed proper for colouring glass, makes, however, no mention of Naples yellow. See his *Philosophical Commerce of the Arts*.

the same proportions of the two metals, and the tartar not being always employed, as Passeri has said; but the inconvenience might easily be prevented, if the workmen who prepare Naples yellow would work according to a sample, as is the case in regard to smalt; and if the different qualities were in the like manner marked by numbers or characters. Fougèroux was informed, from Naples, that there was an old man still living there who prepared this yellow, but that he kept his art such a profound secret that it was apprehended it would die with him. Nothing more of it was known than that he exposed the metals which he employed to the heat of a potter's furnace for twenty-four hours.

Those who attempt to prepare this colour in Germany will not certainly set the same value on the Italian receipt, and that given by Fougèroux; for the diaphoretic antimony, as well as white lead, are too dear—and sal ammoniac, which is not cheap, is lost in the process. On the other hand, some advantage might be gained, if, according to the Italian method, both the metals, with a small addition of an alkaline salt, were reduced to the state of oxyds in an earthen-ware furnace. But our enamel painters prepare a yellow glazing not very different from the real Naples yellow, and for which I find a receipt in a new work*, the author of which seems to be a man of experience, but not of learning. According to this prescription, one pound of antimony, six ounces of red lead, and two ounces of white sand, are to be fused together. The produce, which appears quite black, is to be pounded, and then fused again; and this process is to be repeated till the whole mass becomes thoroughly yellow. Half a pound of this mass is to be mixed with two ounces of red lead, and afterwards fused; and by this tedious process an orange-yellow pigment will be obtained, which, however, might be obtained with more ease and certainty by the method pointed out above.

* Völlig entdecktes geheimniß der kunste fayence, Englisches steingut, und porzellan zu machen. Leipzig, 1793, 8vo, p. 54.

All artists who speak of the use of Naples yellow, give cautions against applying iron to it, as the colour by these means becomes greenish, or at least dirty. For this reason, it must be pounded on a stone, and scraped together with an ivory spatula. It is employed chiefly in oil painting, because the colour is softer, brighter, and richer than that of ochre, yellow lead, or orpiment, and because it far exceeds these pigments in durability. It is employed in particular when the yellow ought to have the appearance of gold, and in this respect it may be prepared with gum water and used as a water colour. A still greater advantage of it is, that it is proper for enamel painting, and on that account may be employed on porcelain or earthen ware *. In the last place I would recommend to artists to examine whether the oxyd prepared from wolfram, by boiling in the muriatic acid, which has a beautiful yellow colour, might not be used in the same manner as Naples yellow †.

IX. *Comparison between the Human Race and that of Swine.*

By I.F. BLUMENBACH. *From Magazin für das Neuëste aus der Physik. Vol. VI.*

SOME late writers on natural history seem doubtful whether the numerous distinct races of men ought to be considered as mere varieties, which have arisen from degeneration, or as so many species altogether different. The cause of this seems chiefly to be, that they took too narrow a view in their researches; selected, perhaps, two races the most different from each other possible, and, overlooking the intermediate races that formed the connecting links between them, compared these two together; or, they fixed their

* In the Memoirs of the Academy of Sciences for 1767 Fougereux has proved that the giallolino prepared by him produced on porcelain a much more beautiful colour than the Naples yellow sold in the shops.

† Gmelin's *Technische Chemie*, p 229.

attention too much on man, without examining other species of animals, and comparing their varieties and degeneration with those of the human species. The first fault is, when one, for example, places together a Senegal negro and an European Adonis, and at the same time forgets that there is not one of the bodily differences of these two beings, whether hair, colour, features, &c. which does not gradually run into the same thing of the other, by such a variety of shades that no physiologist or naturalist is able to establish a certain boundary between these gradations, and consequently between the extremes themselves.

The second fault is, when people reason as if man were the only organised being in nature, and consider the varieties in his species to be strange and problematical, without reflecting that all these varieties are not more striking or more uncommon than those with which so many thousands of other species of organised beings degenerate, as it were, before our eyes.

As my observations respecting the bodily conformation and mental capacity of the negroes * may serve to warn mankind against the first error, and at the same time to refute it, I shall here offer a few remarks to refute the false conclusion which might be formed from a careless comparison of the degenerations among the human race with the varieties among other animals, and for that purpose shall draw a comparison between the human race and that of swine †.

More reasons than one have induced me to make choice of swine for this comparison; but in particular, because they have a great similarity, in many respects, to man: not, however, in the form of their entrails, as people formerly believed, and therefore studied the anatomy of the human

* See Phil. Mag. vol. iii. p. 141.

† See, for example, *Anatomia Porci* of the old Arabian Cophon in the beginning, where he says: Et cum bruta animalia quædam, ut simia, in exterioribus nobis inveniuntur similia, interiorum partium nulla inveniuntur adeo similia ut porci.

body purposely in swine; so that even, in the last century, a celebrated dispute, which arose between the physicians of Heidelberg and those of Durlach, respecting the position of the heart in man, was determined in consequence of orders from government, by inspecting a sow, to the great triumph of the party who really were in the wrong. Nor is it because in the time of Galen, according to repeated assertions, human flesh was said to have a taste perfectly similar to that of swine *; nor because the fat †, and the tanned hides of both, are very like to each other; but because both, in regard to the economy of their bodily structure, taken on the whole, shew unexpectedly, on the first view, as well as on closer examination, a very striking similitude.

Both, for example, are domestic animals; both *omnivora*; both are dispersed throughout all the four quarters of the world; and both consequently are exposed, in numerous ways, to the principal causes of degeneration arising from climate, mode of life, nourishment, &c.; both, for the same reason, are subject to many diseases, and, what is particularly worthy of remark, to diseases rarely found among other animals than men and swine, such as the stone in the bladder ‡; or to diseases exclusively peculiar to these two, such as the worms, found in measles §. Another

* Galen says, in the tenth book of his work on the Power of Simple Medicines, that tavern-keepers and cooks often served up human flesh instead of swine's flesh to their guests, without their perceiving it. He himself was told by persons worthy of credit, that they had ate of such food in a public inn with the best appetite, not knowing what it was till they at length found half a finger, when they became terribly alarmed for fear of the murderous host, who was, however, soon after caught in the fact and punished.

† See *Schwenkfeld Theriotroph. Silesiæ*, p. 127.

‡ Among the wild swine, particularly in Russian Tartary. A pretty large stone of that kind, forming a part of Baron Asch's present, is preserved in the Academical Museum of Gottingen. Domestic swine, however, are in many places subject to this malady. See *Schwenkfeld Theriotroph. Silesiæ*, ut supra.

§ I was guilty of an error when I said, in the third edition of my

Another reason, however, why I have made choice of swine for the present comparison is, because the degeneration and descent from the original race are far more certain in these two animals, and can be better traced than in the varieties of other domestic animals. For no naturalist, I believe, has carried his scepticism so far as to doubt the descent of the domestic swine from the wild boar; which is so much the more evident, as it is well known that wild pigs, when caught, may be easily rendered as tame and familiar as domestic swine*: and the contrary also is the case; for if the latter by any accident get into the woods, they as readily become wild again, so that there are instances of such animals being shot for wild swine; and it has not been till they were opened and found castrated, that people were led to a discovery of their origin, and how and at what time they ran away†. It is well ascertained, that, before the discovery of America by the Spaniards, swine were unknown in that quarter of the world, and that they were afterwards carried thither from Europe. All the varieties, therefore, through

Manual of Nat. History, p. 464, that Goze was the first who placed the animal nature of the measles in swine beyond all doubt. I now find that in the last century Malpighi gave an accurate description of the disease, accompanied also with a figure of the worms. See his *Opera Posthuma*, London 1697, fol. p. 84. "In suisbus verminosis, qui vulgariter *lazaroli* dicuntur, multiplices stabulantur vermes, unde horum animalium carnes publico edicto prohibentur. Occurrunt autem copiosi intra fibras musculosas natum; obvia namque oblonga vesica quasi folliculus diaphano humore refertus, in quo natat globosum corpus candidum, quod disrupto folliculo leviter compressum eructat vermem, qui foras exeritur, et videtur emulari cornua emissilia cochlearum, ejus enim annuli intra se reflexi conduntur, et ita conglobatur animal. In apice attollitur capitulum. A conglobato verme ad extremum folliculi umbilicale quasi vas producitur." The late Werner, as far as I know, was the first who discovered in the human body the same kind of worms as those found in measles swine.

* This experiment was not long ago made with the best consequences in the abbey of St. Urban, in the canton of Lucerne.

† See Lehmann's *Naturliche merkwürdigkeiten im Meissnischen Oeritzgebirge*, p. 605.

which

which this animal has since degenerated, belong, with the original European race, to one and the same species; and since no bodily difference is found in the human race, as will presently appear, either in regard to stature, colour, the form of the cranium, &c. which is not observed in the same proportion among the swine race, while no one, on that account, ever doubts that all these different kinds are merely varieties that have arisen from degeneration through the influence of climate, &c. this comparison, it is to be hoped, will silence those sceptics who have thought proper, on account of these varieties in the human race, to admit more than one species.

I. *In regard to Stature.*

In this respect the Patagonians *, as is well known, have afforded the greatest employment to anthropologists. The romantic tales, however, of the old travellers, who give to these inhabitants of the southern extremity of America a stature of ten feet and more, are scarcely worth notice; and even the more modest relations of later English navigators, who make their height from six to seven feet, have been doubted by other travellers, who, on the same coast, sought for such children of Enoch in vain. But we shall admit every thing said of the extraordinary size of these Patagonians, by Byron, Wallis, and Carteret, the first of whom † assigns to their chief, and several of his attendants, a height of not less than seven feet, as far as could be determined by the eye; the second ‡, who asserts that he actually measured them, gives to the greater part of them from 5 feet 10 inches to 6 feet; to some 6 feet 5 inches, and 6 feet 6; but to the tallest, 6 feet 7 inches: and this account is confirmed by the last-mentioned

* Or rather Pata-chonians, for the people themselves are called *Chonos*; and because their feet, covered with raw hides, gave them a likeness to a bear's paws, they were called by the first Spanish navigators *pata-chonos*. See Forster in *Comment. Soc. Scient. Gottingens.* vol. iii. p. 127.

† Hawkesworth's *Collection of Voyages*, London, 1773. vol. 1. p. 27.

‡ Ibid. p. 153.

of the above circumnavigators*. Now, allowing this to be the case, it is not near such an excess of stature as that observed in many parts of America among the swine, originally carried thither from Europe; and of these I shall mention in particular those of Cuba†, which are more than double the size of the original stock in Europe.

II: *In regard to Colour, and the Nature of Hair.*

The natives of Guinea, Madagascar, New Holland, New Guinea, &c. are black; many American tribes are reddish brown, and the Europeans are white. An equal difference is observed among swine in different countries. In Piedmont, for example, they are black. When I passed through that country, during the great fair for swine at Salenge, I did not see a single one of any other colour. In Bavaria, they are reddish brown; in Normandy, they are all white.

Human hair is, indeed, somewhat different from swine's bristles, yet in the present point of view they may be compared with each other. Fair hair is soft, and of a silky texture; black hair is coarser, and among several tribes, such as the Abyssinians, Negroes, and the inhabitants of New Holland, it is woolly, and most so among the Hottentots‡. In the like manner, among the white swine in Normandy, as I was assured by an incomparable observer, Sulzer of Ronneburg, the hair on the whole body is longer and softer than among other swine; and even the bristles on the back are very little different, but lie flat, and are only longer than the hair on the other parts of the body. They cannot, therefore, be employed by the brush-makers. The difference between the hair of the wild boar and the domestic swine, particularly in regard to the softer part between the strong bristles, is, as is well known, still greater.

* Philosoph. Transactions, vol. lx. p. 20.

† F. S. Clavigero Storia Antica del Messico, vol. iv. p. 145.

‡ Sparmann says, the hair of the Hottentots is more woolly than that of the Negroes.

III. *In regard to the Form of the Cranium.*

The whole difference between the cranium of a negro and that of an European, is not in the least degree greater than that equally striking difference which exists between the cranium of the wild boar and that of the domestic swine. Those who have not observed this in the animals themselves, need only to cast their eye on the figure which Daubenton has given of both.

I shall pass over less national varieties which may be found among swine as well as among men, and only mention that I have been assured by Mr. Sulzer that the peculiarity of having the bone of the leg remarkably long, as is the case among the Hindoos, has been remarked with regard to the swine in Normandy. "They stand very long on their hind legs," says he, in one of his letters; "their back, therefore, is highest at the rump, forming a kind of inclined plane; and the head proceeds in the same direction, so that the snout is not far from the ground." I shall here add, that the swine, in some countries, have degenerated into races which in singularity far exceed every thing that has been found strange in bodily variety among the human race. Swine with solid hoofs were known to the ancients, and large herds of them are found in Hungary, Sweden, &c. In the like manner the European swine, first carried by the Spaniards in 1509 to the island of Cuba, at that time celebrated for its pearl fishery, degenerated into a monstrous race, with hoofs which were half a span in length *.

* Herrera Historia de las Indias Occident. Madrid 1601, vol. i. p. 239.

X. *Account of the Method of making Sugar from Beet Roots, lately discovered by M. ACHARD. Communicated by A. N. SCHERER, Counsellor of Mines to the Duke of Saxe Weimar.*

Weimar, 14th Feb. 1799.

THE newest and most important discovery in Germany is that of the well known M. Achard, director of the physical class of the Academy of Sciences at Berlin, who has at length found a substitute for sugar in the beet root, (*Beta vulgaris*, Linn.) These beets in this country have been hitherto employed as fodder for cattle. The following is one of his principal experiments:—Twenty-five roots, which, in their raw state weighed $32\frac{1}{2}$ pounds, being freed from the rind, bruised, and well pressed, gave, after the residuum had been extracted by boiling water, $19\frac{3}{4}$ pounds of juice. The expressed juice was then put into a tin saucepan, and evaporated to the consistence of honey over a slow fire. During this process the impurities contained in the juice, and which arose from the albumen of the beets, were scummed off. The inspissated salt was next evaporated to dryness over a flower fire, and gave, when pounded, a dry powder of a very bright brown colour, which attracted little or no moisture; it was exceedingly sweet, without the intermixture of any other taste, and weighed two pounds three ounces. The above quantity, viz. $32\frac{1}{2}$ pounds of the raw roots, gave, therefore, two pounds three ounces of raw sugar. By another experiment it appeared, that a pound of this juice contained only $\frac{3}{4}$ of an ounce, or at most one ounce, of gummy and mucilaginous particles: a circumstance which greatly facilitated the separation of the sugar. To obtain a portion of pure sugar from a quantity of juice evaporated and treated as above described, a portion of the juice, inspissated to dryness, was digested with a sufficient quantity of alcohol in a gentle heat; and after all the saccharine matter was dissolved, and the liquor had become perfectly cold, it was filtered

and the residuum properly édulcorated with a suitable quantity of alcohol. When all the spirit of wine had evaporated * over a gentle fire, the quantity of the pure white sugar obtained was such that in general 8 pounds of pure sugar may be expected from 100 pounds of raw beet roots. According to this result, an acre of land, which may produce 46,000 pounds of beet root, will yield 22 hundred weight of raw sugar. If we allow four pounds of beet root to one square foot, a German mile will produce 16,756 [hundred weight 2 quarters and 14 pounds. This is all as yet known respecting the discovery. What M. Achard still keeps secret is the result of his fifteen years experience respecting the cultivation of these beets. He has found that the quantity of sugar to be obtained will depend on the soil in which they are sown, and the method of culture employed. The king of Prussia has not only bestowed a considerable reward on M. Achard for this discovery, but is pursuing every possible means to render it beneficial to his dominions.

XI. Description of an Improved Machine for Cutting Chaff†, invented by Mr. ROBERT SALMON, of Woburn, Bedfordshire. From Transactions of the Society for the Encouragement of Arts, &c. Vol. XV.

WITH this machine the chaff is cut by two knives, A A, (Plate VI.) fixed on the inside of the fellys of two wheels, B B, which are strongly connected together; the edge of the knives being at an angle of about forty-five degrees from the plane of the wheel's motion. These knives are so fixed as to be forced forward by springs, C C, on the wheel; which springs are formed to adjust, and act more or

* Distillation might be employed to save the loss of the alcohol. EDIT.

† Thirty guineas were voted to Mr. Salmon for this improved machine, of which a model is reserved in the Society's repository for the inspection of the public.

less as occasion may require, so as to give the knife as much pressure against the box as may be requisite to cut the straw. The knives are prevented from coming too forward, and occasioning unnecessary friction, by the wedges under the staples *aa*; which wedges, as the knives wear, must be drawn out so as to admit the knives to come more forward. With the before-mentioned provisions it will be found very easy at any time to put on new knives, as the springs, &c. will always adjust them to their work.

On one side of the wheel is fixed a round block of wood, *D*, in which there are four holes and a moveable screw; to this block is screwed one end of the feeding-arm, *E*, running nearly horizontally to the cross bar *F*, at the end of the box *G*; to which cross bar *E* is attached by the pin *b*, moveable to five different holes in *F*, by means of which, and the four holes in the block before described, twenty changes in the length of the chaff may be obtained. The straw is brought forward by the rollers in the box *G*, the form of which is shewn at Fig. 2; which rollers are turned from the outside by the riggers or ratchet-wheels, *H*, one on each side the box, which move more or less, according to the stroke given to the cross bar by the feeding-arm and wheel: by this mode of feeding, the straw is perfectly at rest, and does not press forward at the time of the knife cutting; and, by means of the pin being taken out of the cross bar, the feeding is instantly thrown off, although the wheel and knives may continue their motion. Under the box is suspended the pressing weight *I*, which may be made more or less powerful by shifting the weight on the bearer *K*, to which it hangs, and also may be thrown on either side, more or less, as occasion may require; which will be found useful, in order to force the straw towards the knife, and to counterbalance the ratchet-wheel of the upper roller: near the fulcrum of this bearer is fixed a chain, shewn by the dotted line *c*; its upper-end suspended from a roller; at each extremity of which is a small bar of iron joined to

the end of the upper spiked roller, by which means the straw is always equally pressed in passing the two-spiked rollers.

L. The winch by which the machine is turned.

MM. The frame of the machine.

In order to apply this machine to the best advantage, the inventor proposes a second box to be placed at the end of the first, which box may be of any length, and suspended by a line and counter-weight, whereby the end of it is brought down level whilst filling with straw, and then drawn up, so as to give the said box a declivity, to make the straw more easily come forward.

It is also presumed much advantage may be expected in this sort of machine, from its cutting various lengths—resting during the cut—the knives being adjusted to their work by regulating springs—the feeding being readily thrown off—and the pressure moveable to either side.

It is also well calculated to be applied to any power which may be occasionally fixed to the opposite side of that on which it is turned by hand; and, by the additional box, when used by hand, the workman will be enabled to cut for some continuance, without stopping to feed.

XII. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE. From Journal des Mines. No. XX.

[Continued from page 156.]

CHAP. XII.

Observations to be made on the Valleys.

1. **T**O observe the direction of valleys. Those parallel to the chain of the mountains where they are situated are called longitudinal; those which intersect it at right angles, transversal;

versal; and those which follow an indeterminate direction, oblique.

2. To observe this direction, especially in regard to that of the planes of the strata of the mountains.

3. Dimensions of the valleys; their length, breadth, depth, and the form of their transversal section.

4. The re-entering and salient angles: whether opposite to each salient angle, which forms a side of the valley, the side or opposite mountain forms a re-entering angle; or, on the other hand, whether the valley does not present alternate constrictions and swellings?

5. Whether the opposite mountains correspond by their height, their form, the inclination of their corresponding faces; the situation of their strata, or their nature?

6. Answers to these questions will serve to determine whether the valley may or may not be considered as a large fissure produced by the bursting asunder of the mountains which it traverses.

7. If the lateral valleys which terminate at a principal valley, as the branches of a tree at its trunk, correspond or not; or, in other words, whether the branches of that trunk are opposite or alternate?

The answers to these two questions are very important for the solution of this question: Whether the valleys have been excavated by currents of the sea?

9. Whether there are seen a great number of narrow valleys, of no great depth at their most elevated part, but becoming wider and deeper in proportion as they descend lower, which would seem to indicate that their excavation has been the effect of the fall and descent of water; especially if the strata have the same inclination on each side of the valley, and if its formation cannot be explained by a sinking down or heaving up of the earth.

10. To observe in a valley, the corresponding mountains of which are of the same nature, whether the strata of these mountains do not descend on each side towards the bottom

of the valley, which would indicate that the valley has been produced by a sinking down of the earth, or perhaps by the opposite faces being thrown up.

11. There are two other cases possible when the strata have not the same situation on both sides of the valley.

1. When the strata rise up on each side against the valley.

2. When on one side they descend into the valley, and on the other rise against it. These two cases afford room for suppositions too various to be here detailed.

12. To search on the vertical sides of the valleys for vestiges of the erosion of the water.

13. To observe the bottom of the valley, its breadth, inclination and nature. The vegetable earth, its quantity and quality; fragments, either from neighbouring mountains, or brought from a distance, either angular or rounded; to examine whether they are more voluminous towards the top of the valley. Nature and depth of the strata which are below the vegetable earth; whether the pebbles are larger in the deepest strata: nature of the rock which forms the solid basis of the valley.

14. Whether a valley contains foreign pebbles, that is to say, which come from the neighbouring mountains: to examine to what height they are found on the sides of the mountains; what may be their origin, and what way they may have been conveyed.

15. In the valleys which contain no foreign pebbles, one may follow the traces of those which are there discovered, and thus ascend to the rock from which they were detached: this has often led to curious and useful discoveries.

CHAP. XIII.

Observations to be made on Tertiary Mountains, or those composed of the Wreck of other Mountains.

1. Whether they do not form the external border of other chains of mountains.

2. Whether, at the extremity of great valleys which issue
from

from grand chains of mountains, there are not found small hills and even tertiary mountains, which seem to have been formed by the accumulation of matters deposited by enormous currents that issued formerly from these valleys.

3. Whether their strata do not descend on the side, whence the matter of which they are formed has proceeded?

4. Size and nature of the fragments, sand and earth, of which they are composed.

5. To observe the order which has been followed in the successive deposits of the matters of which they are formed.

6. To compare them with the substances produced by the mountains, whether primitive or secondary, from which they are supposed to have issued.

7. To examine whether there are found there any vestiges of organised bodies.

8. To examine whether there are not found, in their exterior part or surface, strata that seem to have been deposited by stagnant water, or at least water not much agitated; or, on the contrary, whether every thing in them seems to have been transported by some violent movement?

CHAP. XIV.

Observations to be made on Secondary Mountains.

1. To determine with precision the distinguishing characters between primitive and secondary mountains. This is difficult, especially in the genera found equally in primitive mountains, such as slate, serpentines, and some kinds of *trapps* and porphyry. With regard to the calcareous, a granulated fracture seems to characterise the primitive. M. Fichtel, however, doubts this principle, and believes that there are secondary granulated, calcareous, and compact primitives.

2. Is it certain, as Dolomieu asserts, that in secondary mountains there are no strata composed entirely of granulated and crystallised stones?

3. To

3. To determine the respective antiquity of the genera and species of the earths and stones which enter into the composition of secondary mountains. Might we not assign characters by which, in the same genus, we might distinguish the most modern species and varieties?

4. Whether the secondary mountains are always inclined in such a manner as to lean towards the nearest primitives?

5. Whether their superior stratum, especially in the compact calcareous, is not often a *breche**, the angular fragments of which are for the most part of the same nature as the stratum that serves them as a basis, and united by a cement of the same nature†?

5. (A). To observe in the chalk mountains the flints contained there; their bulk, their form, &c.; whether they are disposed in beds; to reflect on their origin: even researches on the petro-flex contained in the compact calcareous stones; and, lastly, the same on the hard *rognons*, or touch-stones contained in the slate mountains: to ascertain whether these petro-flex and rognons are not found in the primitive mountains.

6. Whether there are found in secondary mountains vestiges of organised bodies, and at what elevation. This observation is important above all in the Austral hemisphere‡.

7. Whether there are found, either at their surface, or in their interior parts, rolled pebbles or blocks of a nature different from that of the same mountain, and to what height||?

8. Whether these mountains seem to have been formed by the alluvion of violent tides, or by the accumulated deposits of stagnant water?

9. Whether the secondary mountains do not present them-

* Breche is a kind of hard marble found in the Pyrenees.

† Voyage dans les Alpes, vol. i. § 242. A. and 243.

‡ 6. A. Do not organised bodies contribute sometimes to the hardness of stones, especially those that contain iron, by bringing that iron near to the metallic state? *Hypothesis of Gad in Mem. of the Acad. of Sweden*, 1787. C.

|| See Dolomieu's Memoir Journal de Physique 1791, vol. ii.

selves sometimes in vertical strata, or at least strata very much inclined, and with sharp naked peaks like those of some primitive mountains?

10. Whether, in the same secondary mountain, there are found strata of different kinds of stones oftener than in the primitive?

11. Whether, in secondary mountains, on the other hand, each stone is not generally simple, and not compound as in the primitive?

12. To make researches respecting the origin and antiquity of mountains of gypsum, and their relation with mountains of salt and salt springs.

[To be continued.]

XIII. *Fourth Communication from Dr. THORNTON, Physician to the General Dispensary, relative to Pneumatic Medicine.*

Letter to Dr. Thornton.

DEAR SIR,

Dulwich Common.

I RETURN you many thanks for your kind attentions to Mrs. R. Your method of treatment, under Providence, has certainly performed a wonderful cure. My wife had not inhaled the air three times before I perceived a very great alteration, both in regard to *appetite* and *spirits*; her *strength*, in a week, was also so much restored that she could with ease walk five miles, when before it was quite a fatigue to walk one. I can with pleasure likewise add, that what alarmed us both—the *coldness* of her extremities, and *blackness* under the finger-nails—are both entirely removed, and her nails now appear healthy. As my wife has not enjoyed such good health for several years as she has experienced these last six months, Mrs. R. unites with me in grateful acknowledgements to you.

And I remain, dear sir, your's respectfully,

M. ROBINSON.

Observations. This lady, residing in a country seat, which has a delightful garden, and a good deal of ground attached to it, in an open situation, could not be supposed to want vital air in the blood. Such, however, appeared to be the fact. In such cases I find by the eudiometer, that *the blood is in fault*, attracting but slowly into its bosom the vital principle. But as even the most apparently incombustible bodies readily deflagrate in pure oxygen air, as steel, &c. the same phenomenon might be expected in the human frame; and in the present instance we see that this was actually performed. The good, however, of a temporary inhalation of a super-oxygenated air would have been lost, unless the blood had been altered. Steel was therefore enjoined, together with what is styled the phlogistic regimen; and the event exactly corresponded with my expectations—the radical defect was obviated, the attractive power in the blood was improved, and the blood, coming into contact with a super-oxygenated atmosphere, readily imbibed a large proportion of vital air. The blackness under the finger-nails in consequence soon disappeared, the appetite became quickened, the spirits were increased, and the blood freely passing from the centre to the circumference, and from the circumference back again to the heart, the phlogistic particles decomposing the vital air in the blood in its passage, hence the extremities, and the whole body, became permanently warm.—As the above case may seem to some not sufficient to argue much in favour of pneumatic medicine, I shall beg leave to lay before the philosophic world the following extraordinary cure:

A CASE OF MELANCHOLIA.

Mr. Blundel, æt. 49, a wholesale linen-draper on Holborn Hill, was subject to melancholia above thirty years; that is, he had frequent depression of spirits, without any assignable cause; and this lowness was not casual, but would remain for months with great languor, and was accompanied frequently with a distaste of every thing before agree-

able.

able. Mr. Blundel's only relief was a journey into the country, which he was accustomed to take every year. Having two very eminent physicians as half-brothers, the celebrated chemist Dr. Bryan Higgins, and Dr. Haighton physician to the Eastern Dispensary, the most eminent physiologist of this country, every thing that the art of medicine could do had been employed, but without any material advantage. Mr. Blundel wished, therefore, to make trial of the vital air; and he inhaled it at first under the management of a self-taught genius, his neighbour Mr. Varley, of Hatton-House, Hatton-Garden, and found at that time "an increase of strength" and "his spirits mended." But what struck him most was, "an issue which used to discharge was, since his commencing the air, completely dried up. Another thing he remarked, "that after walking he had varicose tumours in the veins of his legs; but that these did not appear, even after a long walk, since he had inhaled the vital air." I will select a few more observations, as made by Mr. Blundel.

"September 20. Spirits much enlivened after taking the vital air.

"September 22. The same good sensations have continued, although I did not take the air yesterday.

"September 23. Found my mind tranquillized, and somewhat elated towards evening; and when I awoke the next morning, perceived a general glow over the body; the feet, which used before to be always cold, were comfortably warm; the fingers glowed to their extremities, and I could clasp them with firmness; before, they would feel cold and numbed, and I was obliged to rub them before I could close them. All my family observe that my countenance looks less fallow.

"September 25. Spirits continued throughout the day very good. Sleep grateful.

"September 26. The same to-day.

"September 27. The same observations to-day."

I should mention, that when Mr. Blundel applied to me, I desired him to continue the air with Mr. Varley, and ordered

dered a seton in the neck, as the issue was dried up. I directed also bark, columbo, and prepared kali, to correct acidity and brace the stomach, as also to render the blood more attractive of oxygen, and the body was kept regular with aloetic pills; and this plan speedily produced the blessing of sound health, which has continued now upwards of fifteen months, without any disagreeable nervous sensations, and without a single excursion being made into the country.

Observations on this Case. In the case of Mr. Ruffel, which was melancholia, recorded by Dr. Beddoes, the cure was effected without a seton; how much are we therefore to attribute to this application in the present instance? The drying up the issue by the vital air, when employed alone, did it not denote, from the absorption of this principle, an increased energy of the absorbents? I have before noticed, that where serum was discharged, this has happened; but when matter is secreted, there is on the contrary a more abundant discharge, or the serum is converted into laudable pus. In the case of Mr. Fixsen, St. Anne's-Street, Westminster, an issue which could not be made to discharge, began immediately to pour out matter, upon the commencement of the inhalation of the medicinal air. The varicose veins disappearing was a strong mark of increased energy in the circulating vessels. The numbness of the fingers going off, shewed increased action remote from the heart; the glow, the increase of spirits, all declare in marked expressions the influence of vital air; and what makes me the more inclined to this opinion is, that *country air* before used to afford the only relief.

XIV. *Account of the New Machine invented by the late Mr. CUSTANCE, for making Vegetable Cuttings for the Microscope. Communicated by Dr. THORNTON, Lecturer on Medical Botany at Guy's Hospital, &c. &c.*

THE first idea of making vegetable cuttings to be examined by the microscope, originated from the famous
Dr.

Dr. Hooke above a century ago, as may be seen in his *Micrographia*.

“Charcoal, or a vegetable burnt black,” says this eminent philosopher, “affords an object no less pleasant than instructive; for if you take a small round piece of charcoal, and break it short with your fingers, you may perceive it to break with a very smooth and sleek surface, almost like the surface of black sealing wax: this surface, if it be looked on with an ordinary microscope, does manifest abundance of those pores, which are also visible to the eye in many kinds of wood, ranged round the pith, both in a kind of circular order, and a radiant one. Of these there are a multitude in the substance of the coal, every where almost perforating and drilling it from end to end; by means of which, be the coal ever so long, you may easily blow through it; and this you may presently find, by wetting one end of it with spittle, and blowing at the other.

“But this is not all: for, besides those many great and conspicuous irregular spots or pores, if a better microscope be made use of, there will appear an infinite company of exceedingly small and very regular pores, so thick and so orderly set, and so close to one another, that they leave very little room or space between them to be filled with a solid body; for the apparent interstitia, or separating sides of these pores, seem so thin in some places, that the texture of a honeycomb cannot be more porous: though this be not every where so, the intercurrent partitions in some places being very much thicker in proportion to the holes.

“Most of these small pores seemed to be pretty round, and were ranged in rows that radiated from the pith to the bark; they all of them seemed to be continued open pores, running the whole length of the stick; and that they were all perforated, I tried by breaking off a very thin sliver of the coal cross-ways, and then with my microscope diligently surveying them against the light, for by that means I was able to see quite through them.

“ These pores were fo exceedingly fmall and thick; that in a line of them, $\frac{1}{18}$ part of an inch long, I found, by numbering them, no lefs than 150 fmall pores; and therefore, in a line of them an inch long; muft be no lefs than 2700 pores; and in a circular area of an inch diameter, muft be about 5,725,350 of the like pores; fo that a ftick of an inch diameter may containe no lefs than feven hundred and twenty-five thoufand, befides 5 millions of pores, which would, I doubt not, feem even incredible, were not every one left to believe his own eyes. Nay, having fince examined cocus, black and green ebony, lignum vitæ, &c. I found that all thefe woods have their pores abundantly fmallier than thofe of foft light wood; in fo much that thofe of guajacum feemed not above an eighth part of the bignefs of the pores of beech, but then the interftitia were thicker; fo prodigiously curious are the contrivances, pipes, or fluces by which the fuccus nutritius, or juyce of a vegetable, is conveyed from place to place.”

He afterwards fays, “ I took a good clear piece of cork, and, with a pen-knife fharpener as keen as a razor, I cut a piece of it off, and thereby left the furface of it exceeding fmooth; then examining it very diligently with a microfcope, methought I could perceive it to appear a little porous; but I could not fo plainly diftinguifh them as to be fure that they were pores, much lefs what figure they were of: but judging from the lightnefs and yielding quality of the cork, that certainly the texture could not be fo curious, but that poffibly, if I could ufe fome further diligence, I might find it to be difcernible with a microfcope, I, with the fame fharp pen-knife, cut off from the former fmooth furface an exceeding thin piece of it; and placing it on a black object plate, becaufe it was itfelf a white body, and cafting the light on it with a deep plano-convex glafs, I could exceeding plainly perceive it to be all perforated and porous, much like a honey-comb, but that the pores of it were not regular; yet it was not unlike a honey-comb in thefe particulars.”

This is the first rude hint respecting the mode of cutting of vegetables, since which time cutting machines have been contrived by several ingenious mechanics, that might better perform this delicate operation. In 1770 Dr. Hill published a treatise, in which he explained the construction of timber by means of vegetable cuttings examined by the microscope; and he in that work gives an account of a cutting engine, in which a spiral knife is employed; the invention, he says, of Mr. Cummings. The late Mr. Adams, optician in Fleet-street, appears to have contrived a machine for cutting thin sections of wood, in order that the texture thereof might be more visible to the microscope; and in his *Essays on the Microscope*, he says, that this his invention was afterwards improved by Mr. Cummings. Notwithstanding the application of Dr. Hill, and of others who attempted to bring this art to perfection, Cusance, a common carpenter from Ipswich, surpassed every other, and, as Mr. Adams justly observed, continued unrivalled in his dexterity of preparing thin sections of wood, having brought this art to the highest perfection. He cautiously kept his method a secret from every one, and various conjectures were made in what way he accomplished his unrivalled cuttings. When he was alive, I offered him fifty pounds for the discovery, to disclose it to the world for the promotion of science, and in order the better to accomplish my views in my *New Illustration of Linnæus*, where the organisation of vegetables is a particular object of consideration *. When pressed, he offered me the discovery for an hundred guineas, which thinking exorbitant, I gave up all thoughts of it; but, soon after dying, he left in his will, that every thing he possessed should be put up to public auction; and, among other things, his invention of the cutting engine was particularly noticed in the catalogue. They were not, however, exposed to examination, but I did not fail being at the sale to embrace this opportunity of bidding for the two engines, fearful that a mo-

* Representations of all the Cuttings of Cusance will be given in this Work.

nopoly might be made of the art of preparing vegetable cuttings, as had been successfully done by Cusstance. Although the opposition was strong, I was the successful bidder, and became possessed of both engines, which are constructed nearly upon the same principle; and I am happy to embrace the present opportunity of communicating to the public so valuable an acquisition to philosophy and science.

Cusstance's best Cutting Engine described.

Fig. 1. represents a view, and fig. 2. a section, of the cutting machine. It has the appearance of an oblong box, and the sides from the bottom A (fig. 2.) up to B are made of brass. A piece of hard mahogany, C C, is fitted into the brass box, and fills the whole cavity down to *a a*, leaving a void space at the bottom, of sufficient size to admit the parts of the machine which work there, and which are described below. From the top to the bottom of the wood there is a perforation, of which the outline of fig. 3. may be considered as representing a horizontal section, which receives easily a brass socket, fig. 3, in which the wood (*b*) to be cut is secured in its place by means of a brass holdfast *c*, grooved like a float file, and pressed against the wood by the screw *d*. This socket, with the holdfast, (which viewed in front has a fluted appearance) and the piece of wood is represented in its place D, fig. 1 and 2, where it is secured from shaking by means of the piece *e*, fig. 2, pressed against it by the screw *f*, but not so tight as to prevent its being raised when required by the micrometer screw to be yet described. The socket, which fills the perforation from the surface D down to *g*, has a horizontal division at *h*, which serves as a bottom for the holdfast to rest on; the cavity of the socket below *h* receives a piece of metal *i i*, of which fig. 4, is an horizontal section; through this piece, which moves easily up or down in the socket, is a female screw, in which the micrometer screw turns, which may be seen passing through *i i* in fig. 2. The micrometer screw, the neck of which works in a plate *m m*, made fast to the bottom of the piece of mahogany before described by means of the screws

screws $n n$, is prevented from rising or falling, when turned round, by a conical shoulder fitted into the upper side of the plate $m m$, as may be seen in the figure, and by the micrometer index wheel $o o$ made fast to that end of the screw which projects through the lower surface of $m m$. Therefore, when the index is turned, the screw working in i raises or lowers i ; the latter by its form being prevented from turning with the motion of the screw. The piece i , being thus raised as much as the intended thickness of the slip to be cut, presses as it rises against the division b , and by that means makes the brass socket, in which the wood is made fast as before described, to rise exactly the same quantity—care being taken to regulate the pressure communicated by the side screw f in such a manner as just to allow free action to the micrometer screw, and yet to prevent any lateral deviation in the ascent of the socket. A portion of the index wheel comes through the front of the machine (o , fig. 1.) ; and all that is necessary to raise the wood, the parts being previously adjusted in the manner described, is to lay hold of the knob that presents itself at the opening, and move it to the left, a half, a whole, or two divisions, according to the thickness the slip is wished to be cut. These divisions are marked on the circumference of the index, and you note the quantity that passes a stationary point marked over the centre of the opening.

The cutting apparatus is constructed in the following manner :—On the further edge of the upper surface of the box, a flat rule, $G G$, fig. 1, made of steel, is fastened down by the screws $k k$: it is more than an eighth of an inch in thickness, and the front edge of it is ground perfectly straight, and stands at a right angle to the surface on which it rests. Another flat rule, one end of which, H , may be seen projecting past the end of G towards the left, serves as a bed for the cutting knife $r r$, which is made fast to the rule by the screws $s s$. The upper and under surface of this rule are ground parallel to each other, and its back edge is ground straight to

fit against the front edge of the rule G G. The rule H, which is moveable with the knife *r r*, is tapered from the end H, so as to be somewhat narrower at the end next to the cavity D, than the diameter of the pieces of wood that can be contained betwixt the holdfast (*c*, fig. 3.) and the other side of the socket. From this the wonderful simplicity and accuracy of the process, as performed by this apparatus, must be obvious; for the socket, or in other words the piece of wood from which the slip is to be cut, being raised to the desired height by turning the micrometer *o*, all that is necessary is to slide the rule H, with an even hand and pressure, along between the rule G G and the wood to be cut; the taper form of the knife, or rather of its bed, causing it to shave off, as the broad end comes nearer to the socket, a slip from the surface exposed to its action. It should be here remarked, that a portion of the bed (the rule H) is cut away from under the knife, from *r* to *r*, to allow the knife to pass freely over the wood as it performs its office. To keep the wood perfectly fast in its place while the slip is cutting off, besides the holdfast in the socket already described, there is the following contrivance:—A brass spur, *u*, a little thinner than the rule H, having a circular notch at its widest end, which may be moved or made fast at pleasure by means of the screw *v*, is brought up tight against the wood to be cut (the wood being embraced by the circular notch), and then screwed fast; the opening at the narrow end of the spur, through which the screw passes, is in the form of a slit, to allow it to be adapted with ease to different sizes.

As the brass socket rises as well as the wood, (and this is indispensable to secure the parallel rising of the wood after each cut,) it must be obvious, that when, by being raised to allow taking off repeated cuttings, it has been brought almost to the knife, the apparatus must be re-adjusted, and the wood raised in the socket before more cuttings be taken off.

It need hardly be remarked, that the cutting knife is
ground

ground to a perfect true and fine edge, without warp or bend, that it may move through a perfect plane. The accuracy and delicacy with which it works may be judged by fig. 5, which represents a microscopic view of a cutting made from so fragile a substance as a *piece of charcoal*.

XV. Remarkable Instance of a Turkey Cock hatching Eggs.

By M. OEDMANN. From New Transactions of the Academy of Sciences at Stockholm. Vol. X.

MALE fowls, which associate with a plurality of females, care so little for their posterity, particularly in a wild state, that they do not seem to have the least affinity to the young when hatched, and contribute neither towards rearing nor protecting them; on this account M. Oedmann considers the following circumstance to be very singular; such, perhaps, as was never before observed. In the month of May 1789 a turkey-hen was sitting upon eggs, and as the cock, in his solitude, began to be uneasy and to seem dejected, he was allowed to remain in the same place along with her. He immediately sat down by the female, and people at first believed that this was only a piece of gallantry; but they soon found that he had taken some of the eggs from under the hen, which he covered very carefully with his body. The maid, who looked after the poultry, thought this mode of hatching would be attended with little advantage, and therefore put the eggs back under the hen; but the cock was no sooner at liberty than he again carried some of them away as before. M. Haselhuhn, the proprietor, when he observed this, resolved, for the sake of experiment, to let the cock have his own way, and he caused a nest to be prepared with as many eggs as the animal's large body was able to cover. The cock seemed to be highly pleased with this mark of confidence, sat with great patience on the eggs, and was so attentive to the care of hatching them that he scarcely took time to go in search of food.

food. At the proper period 28 young ones were produced; and the cock, who was now in some measure the mother of so numerous an offspring, appeared a good deal perplexed when he saw so many little animals pecking around him and requiring his continual vigilance; but as it is well known that turkeys are so stupid and heedless that they often do not see where they tread, it was not thought proper to trust the cock with this young brood any longer, and they were reared in another manner. M. Carlson remarks on this circumstance, that the total neglect of their young, ascribed to male birds which associate with a plurality of females, is not general. Geese are of this kind, and yet the gander protects the young with the greatest care. But the instance of a turkey-cock sitting on eggs seems the more singular, as both in a wild and a tame state the males are accustomed to destroy the nests of the females, in order that they may have them sooner free for pairing; and for this reason the cock is carefully separated from the hen while she is hatching. The instance related by M. Oedmann is, therefore, the more remarkable.

XVI. *Method of securing Trees from the prejudicial Effects of Frost.* By P. J. B. DI SANMARTINO. From *Giornale Encyclopedico di Vicenza*.

THE surest and most proper method of protecting trees from the destructive influence of frost, is without doubt that which nature itself presents, and which requires to be only a little assisted by art; that is to say, you must deprive the tree, which you wish to defend from the frost, of all its leaves, at a period somewhat earlier than the time when they would drop of themselves. The sap then will be less accumulated in the vessels; it will circulate more slowly, and at the same time become thicker. In that case it will not freeze so readily,

and even if it does freeze, its volume will not be enlarged so much as if it were thinner. M. Strömer made some experiments which seem to confirm the truth of this observation. He plucked the leaves from a few tender branches of a tree before the usual time of their falling; and the consequence was, that the branches thus stripped withstood a considerable degree of frost without sustaining any injury, while those which had not been deprived of their leaves artificially were destroyed. It is to be observed, however, in regard to this experiment, that all the leaves of the tree must not be pulled at the same time, but at three or four different periods some weeks distant from each other, yet in such a manner that the last of the leaves be removed before the usual time of their falling. Were they all pulled off at the same time, a sudden stoppage of the circulation of the sap would be occasioned, which would expose the tree to slow but certain destruction *.

* The following method of securing the blossom of fruit-trees from being damaged by early frosts, is mentioned in the Memoirs of the Royal Society of Agriculture of Paris. A rope is to be interwove among the branches of the tree, and one end of it brought down so as to be immersed in a bucket of water. The rope, it is said, will act as a conductor, and convey the effects of the frost from the tree to the water. This idea is not new, for the following passage may be found in Colerus: "If you dig a trench around the root of a tree, and fill it with water, or keep the roots moist till it has bloomed, it will not be injured by the frost. Or, in Spring, suspend a vessel filled with water from the tree. If you wish to preserve the bloom from being hurt by the frost, place a vessel of water below it, and the frost will fall into it." See his *Hausbuche* Wittenberg, 1608, 4to. vol. ii. p. 131; or the folio edit. of Franckfort, 1680, book vi. chap. 12, p. 203. EDIT.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

DENMARK.

THE Royal Academy of Sciences at Copenhagen, in consequence of Thot's and Classen's Institutions, have proposed the following questions as the subjects of prizes :

I. FOR THOT'S INSTITUTION.

The Society invites all those competent to the task, its present members excepted, to transmit to it a complete essay, founded on experience, respecting any point of agriculture, to be chosen at pleasure, such for example as improving the cultivation of corn land, meadows, pasture grounds, or the planting of timber. It would give the Society particular pleasure to receive complete answers to the following questions.

1. A catalogue, with the botanical and provincial names, of the different weeds, such as the common corn-marygold, dog's-grass, vetches, &c. which are found among the various kinds of grain, in any of the provinces subject to the Danish government; together with methods by which each of these weeds may be most effectually extirpated, and with the least expence.

2. A circumstantial account of the best process by which poor or unfruitful soil, of a determined quality, may be so far improved as to be fit for cultivation; together with an estimate, calculated on an average of several years, of the expences and of the profits to be expected.

3. A proper description of the different varieties of potatoes, which, in proportion to the length of the summer in Denmark, Norway, the Feroe isles and Iceland, might be planted with the greatest advantage; which can afford the best nourishment for men and cattle, and whether, when used in moderation, they are found and wholesome food?

4. A description of the different kinds of oats, and their common varieties. Which of these, considering the difference in the richness of the soil, and the greater or less care possible to be employed in cultivating them, will be most beneficial to the Danish provinces?

The papers must contain a clear botanical definition of the kinds mentioned. It will also be agreeable to the Society, if the author send drawings of the varieties of the oats.

5. Though the Royal Chamber of Finance set on foot the planting of young timber on the moors of Jutland, and the Economical Society encouraged that undertaking by premiums and other inducements, the Society does not think the following question superfluous: What means can be proposed for raising plantations of trees with the least expence, and in the surest and most certain manner, on the heaths, moors, and other places unfit for corn land or meadows?

6. What are the kinds of grass, besides red clover and ryegrass, which can be used in Denmark for sowing in the fields and for improving the pastures?

The author must give such a clear description of these productions as may be intelligible to farmers, together with the Danish and Linnean systematic names, and subjoin the different Danish appellations under which they are known to the country people. He must describe also the method of cultivating each kind; and if the plant be delineated in the *Flora Danica*, he must refer to the figure. He must likewise give the method of cultivating each plant; and where that is unknown, by describing its duration, the time of its blooming, the period of its maturity, and the soil it requires, endeavour to render the farmer capable of cultivating it.

7. The

7. The Agricultural Society long ago recommended the white hawthorn, buckthorn, barberry, hazel, crab-apple and willow for quickset hedges; but as all these are not proper for the same soil, and as there is great want of quickset hedges in the stoney, sandy districts exposed to the wind, because people are not acquainted with the kinds of trees that can be used, or with the method of planting them, though we possess indigenous as well as foreign trees of the bush kind, which in this respect have been either tried in some places or may be recommended, the Society requires to know which of the tree or bush kind, considering the different soils and districts of Denmark, can be employed with the greatest advantage for quickset hedges, and what is the best method of planting them?

The author must give, along with the common and best known kinds, the Danish systematic names; those least known he must briefly describe, and in such a manner as to be understood by farmers. In both cases he must give all the Danish trivial names, and the Linnean systematic appellation of each kind, with a reference to the figure in the *Flora Danica*, if it be there represented. The observations on the utility of each kind of wood for quickset hedges, and the method of planting it, together with the determination of the soil which it requires, must rest upon the grounds of certain experience.

Each of the papers on these subjects will be rewarded by the Society, in proportion to its novelty and the importance of the observations it contains, with 100 dollars; but the best and fullest, when more than one are transmitted, with 200 dollars.

II. FOR CLASSEN'S INSTITUTION.

1. The inventor or improver of the most useful and best machine which can be employed, with most advantage, in agriculture, manufactures, or the mines in the Danish European

ropean possessions, will be rewarded by the Society with 200 dollars. The papers must be accompanied with proper models or accurate drawings.

2. For the construction of harness, by which horses, without being confined or hurt, may be able to draw in the easiest manner, particularly when employed in agriculture, as in ploughing, harrowing, rolling, drawing corn-carts, &c.; and also in more laborious works, such as drawing stone-carts, waggons, cannon, &c.; the Society will bestow a reward of from 100 to 200 dollars, in proportion to the importance of the proposed improvements.

The author must write his name and place of abode in a sealed note, inscribed with some device; and the papers with the same device must be transmitted, post paid, before the end of June 1799, to Professor Abildgaard, secretary to the Society.

HOLLAND.

The second Teylerian Society have proposed the following prize questions for the year 1799:

As it is of great importance towards the improving and extending every branch of physics that the present state of our knowledge in that respect should be ascertained, and that every thing which has been sufficiently proved by experience should be accurately distinguished from what may be considered only as conjecture, the Society requires to know what is the present state of our knowledge in regard to the aqueous vapours of the atmosphere?—How far can we explain, on well founded experience, by what causes water is received into the atmosphere in the form of vapour, or in any other manner, and retained there; and to what causes is it to be ascribed that the water retained in the atmosphere is disengaged and falls down under different forms? Moreover, can all aqueous vapours be ascribed merely to the disengagement of the water in the atmosphere, or have any observations

tions been made which clearly shew that water sometimes is produced in the atmosphere?

The Society will reward the author of that paper which shall treat this subject in the clearest manner, and throw most light upon it, with a gold medal of the value of 400 florins.

The answers must be written in the Dutch, Latin, French, English or German (but not with German characters) in the usual manner, and transmitted with a sealed note containing the name of the author, to the house of the Teylerian foundation at Haarlem, before the 1st of April 1800, that the prize may be adjudged before the 1st of November the same year.

As no answer was transmitted before the fixed period to the physical prize question for 1797, the Society have thought proper to propose it a second time. The prize is a gold medal of the same value as the above. The question is as follows :

What certain knowledge have we respecting the nourishment and growth of plants; or how far can we at present conclude, from certain and decisive experiments and observations, what the substances or principles are which chiefly afford nourishment to plants, and how they receive, secrete, and assimilate them?—What circumstances relating to this subject, asserted by respectable philosophers, are still to be considered as doubtful?—By what experiments might our knowledge in this respect be with probability enlarged and confirmed?—And lastly, What can be deduced from the knowledge here required respecting the nourishment and growth of plants, which might be practically applied in order to cultivate useful plants in many kinds of soil with more success?

The chief object of the Society, in both the first divisions of this question, is, that the present state of this part of our knowledge respecting plants may be accurately ascertained, and that what is fully proved may be clearly distinguished
from

from what rests only upon weak grounds. The intention of this part of the question will therefore be sufficiently fulfilled, though the author may not be able to enrich his answer with new discoveries.

Those who wish to become candidates for this prize must pay attention to some of the modern publications upon the same subject, and in this respect much information may be obtained from F. A. Humboldt's *Aphorisms drawn from the chemical physiology of plants* *.

GERMANY.

On the 13th of January last the Mineralogical Society of Jena celebrated, at the ducal palace there, the first anniversary of their establishment: on which occasion the director, Professor Lenz, gave a history of the Institution, and of the progress of the Society; M. Samuel Nagy, secretary of the Hungarian nation, read a chemico-mineralogical history of Hungary; M. Von Ori of Kots in Hungary, delivered a congratulatory address in Latin; M. Aarn of Leibitz, in Hungary, delineated a view of the great importance of mineralogy to Hungary; Dr. Von Gerstenberg shewed the influence of mineralogy on the wants of human life and the prosperity of society; and M. Panfner, of Arnstadt, gave a short view of the superstitious employment of many species of stones in ancient and modern times.

The sitting was closed by the Secretary returning thanks to the members assembled for the part they had taken in promoting the object of the Society; and by M. von Pazmandi, of Bong in Hungary, expressing his wishes for the future success of the Institution.

His serene highness the duke of Saxe Weimar and Eisenach has been pleased to grant the Society permission to hold their future sittings in the large hall of the ducal palace,

* The title of the original is F. A. Humboldt's *Aphorismen aus der Chemischen Physiologie der Pflanzen*. Leipzig 1794, 8vo.

and to deposit their collection of minerals and books in the museum of Charles Augustus.

In the public sitting of March 3d, the director, Professor Lenz, read a short view of the latest discoveries in mineralogy; Dr. Von Gerstenberg explained the reasons which occasioned the regality of mines to be established; M. Panfner, of Arnstadt, controverted the grounds adduced for the Meisner † being of a volcanic nature; and M. Theil of Iglo, in Hungary, illustrated the influence which natural philosophy has on mineralogy.

BRITISH MINERALOGICAL SOCIETY.

The want of a Society in this kingdom, whose attention should be directed to the analysis and reduction of our native ores and minerals, has been felt for a considerable time. It is with pleasure, therefore, we announce that a Society under the above title has recently been instituted, which promises to be of considerable public utility; as it proposes to analyse, free of expence, for the proprietors of mines or landed estates, whatever substances they may meet with in sufficient quantity to render a knowledge of their component parts a desirable object. We hope, in our next Number, to be able to lay the plan of the Society before our readers.

† The Meisner is a mountain three miles from Cassel, which, according to measurement by the barometer, rises 1959 Paris feet above the surface of the neighbouring river, and 2184 feet above the level of the sea. Its upper part consists of masses of basalt, some columns of which are 20 feet in length, and from 5 to 8 inches in thickness. It contains also coal. It has been declared to be of a volcanic nature by Fayjas de St. Fond and Van Marum, who both examined it. EDIT.

MISCELLANEOUS.

CHEMISTRY.

THE following process for preparing *aurum musivum* of a most beautiful quality has been announced by Brugnatelli: Precipitate a solution of the nitrat of tin by liquid sulphure of potash, dry the precipitate and put it into a retort with half its weight of sulphur and a quarter of the muriat of ammonia; you will then find the sulphure of tin formed at the bottom of the retort, and of a most brilliant appearance.

In a former Number of this Work (Vol. II. p. 331), when laying before our readers an account of the present state of Chemistry in Germany, we mentioned the favourable account given by M. Van Mons of Brussels, of the Elementary Treatise on Chemistry published by Professor Gren, whose death we announced in our last Number. A letter which we have since received from M. Scherer of Weimar, speaking of Mr. Gren's death and of his writings, says, "His System of Chemistry, on account of its perspicuity and correctness, has obtained in Germany a decided preference over every other elementary work of the kind." This work we are happy to find has been translated into English, and will soon be published in 2 volumes 8vo size. It contains all the facts relating to chemistry known up to 1796, as far as they come within the compass of an elementary treatise, explained on the principles of the new theory. The few discoveries since made have, we understand, been added by the translator in occasional notes; and, at the end, an account of the two new metals, Tellurium and Chrome.

EXCREMENT OF PLANTS.

Brugmanns, in a dissertation on *lolium** (darnel), was the first who proved that plants, like animals, free

* Dissertatio de lolio, ejusdemque varia specie, noxa et usu, 1785.

themselves from impure juices by the means of excretions *. He placed that plant in a transparent vessel filled with water, and observed every day, at the extremity of the roots, a small drop of a viscous matter. This drop he removed, and next day there was another. All plants emit, in the same manner, from the extremities of their roots, and particularly during the night, small drops of a liquid which is extremely prejudicial to them. It is hurtful also, very often, to those plants which are near them; at other times it is useful to them: thus oats suffer much from the *serratula arvensis*; flax, from the *euphorbia peplus* and the *scabious* of the fields; wheat, from the *erigeron acre*; sarrafin, from the *spergula arvensis*; and carrots, from *comfrey*.

These phenomena may serve to explain why farmers are obliged to let their lands rest a year; for, during that interval, this humour has time to be decomposed. By the same means may be explained, why land exhausted with one kind of plant causes others to vegetate with vigour: the fæces of the former hurt plants of the same species, and serve as manure to others. A field, for example, exhausted with bearing clover, if sown with wheat, will produce an abundant crop, because the fæces of the clover are, without doubt, a manure for the wheat.

MINERALOGY.

A very singular species of iron ore has lately been discovered in Shropshire, which may truly be considered as a national acquisition. It yields, on the first reduction, *malleable* iron, instead of cast iron, as is usual from other ores; and the product is very large. From an hundred parts of it, previously torrefied, which we reduced in the assay furnace in the common manner, we obtained a malleable button which weighed sixty-seven parts. The stratum, which is of

* *Plantas animalium more cacare primus exploravit vir indefessus Bruggmanns, says Humboldt in his Aphorisms. Flora Fribergensis.*

the great thickness of 2 feet 4 inches, was discovered when digging for coal.

Dr. A. N. Scherer, of Weimar, writes us, that Professor Abildgaard, of Copenhagen, has lately obtained from Greenland a fossil, which, on analysis, is found to contain alumine in combination with the fluoric acid—a mineralogical phenomenon not before met with.

Sulphat of strontian, which has hitherto been so scarce an article in this country, has lately been found in great quantities in the neighbourhood of Bristol. It was at first believed to be merely a variety of sulphat of barytes, till Mr. William Clayfield, wishing to obtain some muriat of barytes, reduced a portion of the mineral in the muriatic acid, when its great solubility, with its needle-formed crystals, soon indicated the presence of strontian. In the neighbourhood of Ham-green a variety of this rare production is found breaking through the soil in such large masses that it has been made use of in mending the roads.

PHOSPHORESCENCE OF WOOD.

Dr. Carradori, in a paper on the phosphorescence of wood, asserts that phosphoric wood acquires by putrefaction the property of attracting and absorbing light, and of retaining it mechanically. To make it shine, it is sufficient to expose it for some time to the sun. A bit of wood, which the author examined, continued to shine under oil for two whole days. In that situation, says Dr. Carradori, it was not in contact with oxygen gas.

DIURNAL MOTION OF THE EARTH.

In a work lately published, entitled, *De diuturno terræ motu experimentis physico-mathematicis confirmato*, with ninety copper-plates, the author, Professor J. Baptista Guglielmi, of Bologna, giving an account of several experiments which he made on the falling of heavy bodies, says, that, in a height of 241 feet, he found a deviation of

$8\frac{1}{2}$ lines towards the east, from a perpendicular direction, which amounts exactly to as much as, according to his calculation, is produced by the diurnal motion of the earth. De la Place, of Paris, disputes a part of this deviation, and, according to his calculation, admits no more than five lines. This is adduced as a new proof of the rotatory motion of the earth.

PHYSIOLOGY.

Dr. Carradori, in a letter to M. Lassi on the digestion of nocturnal birds of prey, considers it as fully established that these birds digest vegetables. It results from his experiments, that they can be supported extremely well with that food, though it is repugnant to their nature. Dr. Carradori has therefore destroyed the erroneous opinion that the gastric juice of these animals had an affinity only for animal substances: what he establishes by his experiments, that carnivorous animals find nourishment in the produce of plants, was before rendered probable by the discovery made by Fourcroy of the existence of gluten, albumen, and gelatinous matter in vegetables.

The same author has ascertained, by new experiments, that breathing is necessary to aquatic frogs for the support of life. He observed, that these animals held under water lived a much longer time when the jars were open than when they were shut, and that their existence was prolonged in proportion to the volume of the air around them. Under water covered with a stratum of oil they lived only a short time. In pure oil they died in the course of 40 minutes. The author was desirous to try also how far water was necessary for supporting the life of these animals. He observed, that frogs kept in water up to the belly died a third sooner than those kept entirely dry. Fish inclosed in a jar partly filled with air, consumed none of that fluid.

MEDICAL LITERATURE OF THE NORTH.

Professor Pfaff of Kiel, and Dr. Scheel of Copenhagen, have announced a new periodical work, the object of which is to give an account of every thing that relates to the state of medicine in the North, under which the editors comprehend the Danish States, including Holstein, Sweden, and the northern part of Russia. The work will embrace surgery as well as medicine, both in theory and practice; and physics and chemistry, so far as they are connected with these branches of science, will not be excluded from their plan, of which the following are the outlines. 1. The theory of medicine. 2. Practical medicine. 3. Surgery and midwifery. 4. Northern medical and chirurgical literature. 5. Medical institutions and medical policy of the North. 6. Intelligence. The editors have received assurances of support from the principal physicians in the North, among whom are Saxtorph, Abildgaard, Callisen, Hensler, Weber, Fischer, Hedin, Herholdt, &c. The editors do not mean to confine themselves to any regular periods of publication; but will endeavour to publish a number, consisting of twelve sheets, every three months. The first number was to appear at Easter 1799.

Dr. K. A. Rudolphi, also of Greifswald, has announced a work somewhat similar, to be entitled *Swedish Annals of Medicine and Natural History*; two numbers to be published annually, according as materials can be procured. The editor, who was born at Stockholm, means to make extracts from every work on medicine or natural history printed in Sweden; and as a copy of every Swedish publication of importance is procured for the academic library at Greifswald, he hopes he shall be able to give in these Annals a complete view of the present state of medicine and natural history in his native country. The first part was to be published at Easter 1799, by Lange at Berlin.

ASTRONOMY.

The following account of the objects discussed by Lalande and the German astronomers, &c. who met last summer at Gotha, has been published by Professor Bode of Berlin, in his *Astronomical Almanack* for the year 1801.

“ In the month of January 1798, Lalande gave public notice that he intended, in the course of the Summer, to make a tour to Gotha, partly to see the celebrated observatory at that place, and partly to pay a visit to his learned friend and old correspondent Major Von Zach. On this occasion he wished, in particular, to form a personal acquaintance with several German astronomers, some of whom had long kept up an epistolary correspondence with him; and many of them, among whom I was one, received the most flattering invitation to meet him.

“ I resolved to undertake this jaunt; to which I was encouraged, in particular, by M. Von Hahn of Remplin, who, however, was not able to accompany me. I accordingly obtained his majesty's permission, and having learned that Lalande, with his niece, Madame le Français, had arrived at Gotha on the 25th of July, I set out on the 7th of August, by Leipzig, Naumburg, and Erfurt; and on the 9th reached Gotha, where I had the pleasure of becoming personally acquainted with the long celebrated and meritorious French astronomer and his learned niece, and of embracing my worthy friend Von Zach. At the duke's court I met with the most gracious reception; but the unfavourableness of the weather deprived me, in a great measure, of the satisfaction of using the noble instruments in the observatory; for, during the time which I spent there so agreeably, the atmosphere was overcast, and storms and rain prevailed. The astronomers and others present were: Professor Klügel, Professor Gilbert, and M. Pister secretary of the post-office, from Halle; Professor Seyffer, from Göttingen; M. Köhler, and M. Seyffert, from Dresden; M. Schaubach, from Meiningen; and M. Feer architect, from Zurich. The other

German literati who had received an invitation, sent excuses for not accepting it.

“ Among the various astronomical and mathematical objects discussed on this occasion were the following :

“ Lalande wished that the decimal system some time ago proposed in France to be used in astronomical and mathematical calculations, in the division of time and of the circle, in instruments for long measure, in weights, coins, &c. might be introduced into Germany. We, on the other hand, represented to him the difficulties, in regard to common life, which opposed, and which would perhaps ever oppose, the general adoption of this system, otherwise useful in calculation ; and that men of letters were the least of all fit to remove these difficulties : we, however, agreed that in future we would favour this system more in our writings, in order to make it better known ; and we at the same time expressed a hope that the National Institute of Paris would transmit to us the new tables for the decimal calculation, as soon as they were published, which Lalande promised to use his interest to effect.

“ He mentioned also the general adoption of the new standard proposed in France, called the *metre*, or the linear unity of 10,000,000 parts of a quadrant of the earth's meridian ; because, in his opinion, it was borrowed from nature itself, and therefore was equally proper for all nations. But we could give him very little hope in regard to the introduction of the metre in Germany ; especially as the French foot is already used in comparing measures, and its exact length every where known. We, however, resolved to give, in future, foreign measures according to the metre, as we formerly gave them by the French foot, as soon as the exact length of the former should be made known to us by the grand measurement now carrying on in France, but not yet completed*. We agreed also to give in future all calcu-

* This undertaking has been since finished. EDIT.

lations and astronomical observations, as well as the places of the heavenly bodies in astronomical books, for the mean time, as soon as the editor of the *Connoissance des Temps* should set us the example. Perhaps it will be possible also to introduce this mean time into common life, in order to effect a better regulation of the going of watches.

“Accurate and more numerous observations of the time of the moon’s culmination were next recommended, as these might serve in determining the difference of meridians of places; also to insert in astronomical almanacks the time of the occultation of stars of the fifth and sixth magnitude, before the first, and after the last quarter of the moon, in order to give occasion to more frequent calculations of these differences. In calculating the oppositions of the superior planets, for examining the theory of their orbits, the same method must absolutely be followed; and that given in Lalande’s *Astronomy*, section 4162, was here proposed.

“I produced a complete drawing of the fifteenth sheet, and the two engraved, but not yet finished sheets, tab. 11 and 12, of my large *Celestial Atlas*, and the manuscript of my *Complete Catalogue of the Stars*, and particularly the part respecting De la Caille’s Southern Stars, which have never yet been numbered. Lalande took this occasion to observe that room might still be found on some of the celestial charts for new constellations, and wished to see inserted among the stars an *aérostat*, as the invention of the French. I embraced this opportunity, contrary to my former firm resolution of introducing no new constellations, to propose, on the other hand, that a German discovery, made 350 years ago, viz. the art of printing, might be perpetuated in the heavens by some emblem. Both proposals were approved. The first constellation will be inserted between the Goat and Southern Fish; and the other between the Ship, Unicorn, and Greater Dog.

“Lalande was convinced, at the same time, by ocular demonstration, of the accuracy of observations made with a

Hadley’s

Hadley's sextant on the Infels Berge, one of the highest forests of Thuringia, where the dukes gave a fête to the company, and where we took several corresponding altitudes of the sun with various ten-inch sextants by Troughton, in order to determine the time and height of the pole.

“Lalande had with him a chronometer by Berthoud the elder at Paris. The duke of Gotha has in his possession four English chronometers, by Arnold, Emery, Mudge, &c. Major von Zach has one by Emery, and M. Seiffert of Dresden one made by himself. All these were compared with pendulum clocks, and with each other; and their rate of going was found to be remarkably regular, which proved that they were fit to be used in determining the longitude. Seiffert also shewed, merely to give pleasure to Lalande, a clock constructed by himself, according to a new invention, and having marked on the dial-plate the diurnal division of the day proposed in France. He had likewise with him, of his own workmanship, a stop watch with the decimal division, which he presented to Madam le Français.

“Some new instruments and maps were also exhibited and examined. Among these were an ocular heliometer, to be applied to a Herschel's telescope, invented by M. Köhler, and constructed by M. Seiffert; the diaphragms of the former, for determining the strength of the light of the stars, and his proposed vessel for an artificial water horizon; a map of the Rhein Thals, laid down by means of a Hadley's sextant, by M. Féer of Zurich; some sheets of the new map of the duchy of Wurtemberg, by M. Bohnenberger of Tübingen, measured and delineated by means of like instruments. The beautiful instruments on the ducal observatory of Seeberge, near Gotha, and the convenient and proper manner in which they are erected, obliged Lalande to acknowledge that he had never seen any where an observatory so well furnished.

“Of the new French calendar, and their manner of reckoning by decades, as well as their proposed decimal division

of the day, there was no discussion. Lalande himself must have been aware, that as the introduction of this innovation found, even in France, and particularly in the provinces, so great opposition, it would meet with much more in other countries. It would also hardly find admission among those who have still any regard for institutions which, thousands of years ago, the first law-givers and astronomers declared to be proper for civil life, and which have since been retained through all ages. Besides, this new French calendar, in making the year begin at the entrance of the sun into the equinoctial point, determined by astronomical calculation, brings it back upon no solid and sure grounds; while we, on the other hand, by the very simple method of intercalation, can determine common time backwards and forwards for many centuries, and differ only one day from astronomical time in the course of 3200 years."

The Elector of Saxony has enriched the observatory at Leipzig with a considerable number of astronomical instruments, which were before preserved in the mathematical hall at Dresden.

SYMPATHETIC INKS.

On this subject a correspondent has sent us the following communication:

"Many receipts have been already published for making inks, the writings with which remain *invisible* till brought forth by heat; but many inconveniences attend even the best of them. Having tried all I have been able to meet with, I have found that some require so much heat that the whole paper is scorched before the letters make their appearance; that in some the letters are indistinct when produced; and that in others the words are almost legible before the heat is applied. In the course of my experiments on this subject, I hit upon a very simple mixture which obviates these inconveniences; as the writing done with it is perfectly invisible till heat be applied, and becomes very black with such a de-

gree of heat as will not injure the paper. It is also very durable, may be kept long before it is put to the fire, and will retain its colour long afterwards. It consists of sulphuric acid, and three times the quantity of water mixed together.

“The thing is so simple that I can hardly think it can be new: it was, however, unknown to me till I discovered it; and if it has not before been published, it may amuse some of your readers.

“There is one inconvenience attending this ink, which is common to all of this nature: it injures the parts of the paper on which the letters are written. All these inks owe their property to some corrosive substance, which being acted upon by the fire, renders the writing visible, by reducing those parts of the paper on which the ink has been applied, to a kind of charcoal.

“*Cambridge, March 29, 1799.*

J. D.”

STATISTICS.

List of the Births, Deaths, and Marriages, in several countries and cities of Europe, for 1798.

	Born.	Died.	Pairs married.
Abo in Sweden	310	260	100
Amsterdam	6406	4769	2313
Augsburg	998	1163	325
Berlin	6206	5136	1070
Copenhagen	3351	3717	2238
Florence	3406	1696	—
Franckfort on the Mayne	999	1002	310
Göthenburg in Sweden	460	347	157
Groningen	960	646	308
The Hague	—	1466	563
Hamburgh	3512	3842	1492
Hanau	434	358	117
Hermanstadt in Transylvania	392	374	116
Königsberg	2203	2134	591
			London

	Born.	Died.	Pairs married.
London	17927	18155	—
Magdeburg	1017	973	320
Mannheim	718	630	202
Munich	1682	1799	308
Pomerania, Prussian	17717	11140	4349
Prussia, Eastern	32808	26826	8661
Rotterdam	1673	2025	666
Russia, the Eparchy of Braz- law excepted	991915	540390	257513
Sheffield	1646	1372	431
Stutgard	800	797	182
Thorn, Protestants	179	103	139
Tubingen	228	146	72
Ulm	570	525	169
Vienna	11595	13370	2765
Zealand without Copenhagen	8244	6807	—
The Diocese of Aarhuus	4268	2359	1325
———— of Fühnen	6205	4766	—
———— of Ripen*	3851	2798	1110

Of those who died at Vienna, 1309 were carried off by consumptions, 612 by the small-pox, 472 by apoplexy, &c. The births exceeded the deaths by 1775. Of those born at Berlin, 3038 were males, and 2968 females; 568 were born out of wedlock: there were also 66 pair of twins, and one instance of three at a birth. Of those who died, 2414 were adults, and 2722 under age.

Of those born at Konigsberg, 1159 were males, and 1044 females. Of those who died, 1100 were males, and 1034 females. The births exceeded the deaths by 69. Among those born were 12 pair of twins, and 399 born out of wedlock. Among those who died, ten were between 90 and 100 years of age; and one man had attained to his 100th: 34 persons lost their lives by accidents,

* These three dioceses belong to Denmark. Epit.

Among those who died in Prussian Pomerania were two men and three women 100 years of age, and three men and four women of from 101 to 105.

Of those born in Russia, 531015 were males, and 460900 females: of those who died, 275583 were males, and 264807 were females. The births exceeded the deaths by 451525.

It is to be remarked here, in general, that the mortality in the Southern part of Europe is considerably greater than that in the Northern part, London and Copenhagen excepted. The cause of these forming an exception, is, perhaps, their being populous capitals.

MANUFACTURES.

M. Möglich, member of the privy council of Wirtemberg, lately deceased, found out, a little before his death, a new method of making ropes, the threads of which are not twisted as usual and wound round each other, but bound together straight and in a parallel direction. The celebrated Muschembrock discovered, by several experiments, that threads and cords, not twisted, formed stronger ropes than those which were twisted; but he never could discover a proper method of uniting parallel threads together. The brothers, Landauer at Stuttgardt, have, however, begun a manufactory of this kind, which will be of great utility for shipping. It has been found by experiments that such a rope, wove of yarn worked together, $1\frac{3}{4}$ inch in diameter, supported 13 hundred weight without breaking; and when it was at length made to give way by a greater weight, it broke as if it had been cut with a pair of scissars; a proof that all the threads had experienced an equal degree of tension. A wove rope of this sort, containing 504 threads, $3\frac{3}{16}$ inches in diameter, and 111 feet long, weighed no more than 19 pounds, whereas a common rope of the same dimensions, and the like number of threads, weighed $31\frac{1}{2}$ pounds.

METEOROLOGY.

The severe cold that prevailed during the course of the late winter, induced the celebrated astronomer Lalande to publish, in one of the French Journals, the following list of years which were remarkable for the intenseness of the frost, viz. 763, 801, 1067, 1210, 1272, 1305, 1354, 1358, 1361, 1364, 1420, 1460, 1480, 1493, 1507, 1522, 1608, 1638, 1655, 1657, 1663, 1670, 1677, 1699, 1740, 1776, 1788.

ENGRAVING.

Lagarde, a bookseller at Berlin, has begun an undertaking, never perhaps before attempted, at least in Germany. He means to publish a Greek edition of Homer, entirely printed from copper-plates. Professor Wolf, at Halle, is to supply the text, and the work will be executed with the utmost care possible. Jäck is to engrave the plates, from the best specimens of Greek writing.

DEATHS.

On the 16th of December last, at Halle, in the 70th year of his age, John Reinhold Forster, LL.D. professor of natural history in that university, member of the academy of sciences at Berlin, and of other learned societies. He was born at Dirschau, in West Prussia, in the month of October 1729, and was formerly a Protestant clergyman at Dantzic, from which he went to Russia, and thence to England, where he pursued his favourite study, Natural History. From 1772 to 1775 he accompanied Capt. Cook in his voyage round the world. On his return he resided at London, till he was at length invited to Halle, where, for 18 years, he was a member of the philosophical and medical faculties. Among his works are: *An Introduction to Mineralogy, or, An accurate Classification of Fossils and Minerals, &c.* London, 1768, 8vo. *A Catalogue of the Animals of North America, with short Directions for collecting, preserving, and transporting all Kind of Natural Curiosities*, London, 1771, 8vo. *Observations made during a Voyage round the World, on Physical Geography, &c.*

&c. London, 1778. He was the author of a great many productions in English, Latin, or German, and of several papers in the Philosophical Transactions. He translated into English, Bougainville's Voyage round the World, and Kalm's, Boffu's, and Reidfel's Travels. He was employed likewise, when in England, in the Critical Review; and he wrote various detached papers on different subjects, which have been inserted in foreign Journals and the Transactions of learned academies. His son, George Forster, who also went round the world with Capt. Cook, and was afterwards professor of natural history at Cassel, died at Paris, at the age of 39, on the 13th of February 1792.

Not long ago, at Hamburgh, the celebrated portrait and historical painter Hickel. He distinguished himself particularly by his happy talent of giving good representations of family scenes and children. He studied at Vienna, and enjoyed there for a long time a considerable pension, which Joseph II. however at length withdrew. He resided after this sometimes in Swisserland, and sometimes in London and Paris. The late queen of France often sat to him, as did also the princess of Lamballe, who caused herself be painted sometimes as a nosegay girl, and sometimes as a fortune-teller or nun. In the year 1793 he began to paint a sitting of the British house of commons, and most of the portraits were striking likenesses. From this painting, which was 15 feet in breadth and 11 in height, he proposed publishing a print by Cheefeman; but, owing to some disappointment in regard to the subscription, the undertaking was abandoned. During the last days of his life he made a painting of Klopstock, and exceedingly like. The poet is represented sitting and reading one of his favourite odes. Hickel, at the time of his death, proposed to have a print from this painting, 19 inches by 16, engraved by Huck.

At Geneva, on the 22d of January, Horace Benedict de Saussure, well known as a naturalist, chemist, and mineralogist. He was born in 1740, stood candidate for the mathematical

matical chair of that city in 1760, and in 1762 was appointed professor of philosophy. He was a member of most of the learned societies in Europe, and author of many works; among which are, *Travels through the Alps*, published first in quarto, and afterwards in octavo; *Essays on Hygrometry*, *Observations on the Epidermis of Leaves and Petals*, &c. For a list of his smaller treatises, see Senebier's *Literary History of Geneva*, vol. III.—M. de Saussure enriched natural philosophy also with two valuable instruments, a portable hygrometer and electrometer. He had in his possession a most beautiful cabinet of natural history; and an herbal, remarkable not only for the number of plants it contained, but also for their fine state of preservation.

On the 5th of February, at Bologna, in the 55th year of his age, the celebrated Galvani, from whom Galvanism, which has made so much noise in the philosophical world, took its name. It is said that a fit of illness, by which his wife was attacked, led him to the discovery of his theory respecting metallic irritation. The physician having prescribed for his wife soup made of boiled frogs, Galvani, who was an affectionate husband, prepared them himself; and having accidentally touched a frog after he had skinned it, he observed in it an involuntary motion, which induced him to make some experiments that conducted him to the discovery.

At Pavia, on the 11th of February, of an inflammation in the urethra, Lazarus Spallanzani, of Reggio, the celebrated natural historian.

On the 18th of February, at Leipzig, John Hedwig, professor of botany, in the 68th year of his age. His researches respecting the cryptogamia class of plants will secure him immortal fame. His death will be a great loss to the General Literary Journal of Jena, to which he was a contributor, and which was indebted to him for many interesting communications.

On the 24th of February, at Göttingen, George Christopher

pher Lichtenberg, Esq. counsellor of state to his Britannic majesty, and public professor of philosophy in that university. He was born at Ober-Ramstadt, near Darmstadt. On the 19th of February he read a public lecture, next day he was confined to bed, and on Sunday morning an inflammation of the breast put a period to his existence. By this event the university of Göttingen lost an excellent teacher, and Germany one of its most ingenious writers, who, to profound knowledge in the most sublime sciences, united an unexhaustible fund of original genius.

Not long ago at Paris, in the 64th year of his age, Charles Borda, an eminent mathematician, and one of the authors of the new French system of weights and measures. He was a *Lieutenant de Vaisseau du Roi* under the old French government, and with De la Crene and Pingré made a voyage to America, in order to ascertain the utility of certain instruments for determining the latitude and longitude. The account of this voyage was published under his inspection, with the title of *Voyage fait par ordre du Roi en 1771 et 72, en diverses parties de l'Europe et de l'Amérique, pour vérifier l'utilité de plusieurs methodes et instrumens servant à déterminer la latitude et la longitude tant du vaisseau que des côtes, isles et ecueils, &c.* par MM. Verdun de la Crene, Le Chev. de Borda, et Pingré, 1778, 2 vol. 4to. He was the author also of *Déscription et Usage du Cercle de Reflexion*, 1787, 4to. and of several physical and mathematical memoirs in different journals. He has been succeeded in the *Bureau des Longitudes* by C. Bougainville.

On the 7th of this month, at his house in Queen-square, Westminster, the Rev. Clayton Mordauut Cracherode, A.M. Student of Christ Church, Oxford, F.R.A.S. and one of the Trustees of the British Museum.

Mr. Cracherode was eminent for his erudition, liberality of sentiment, and amiable manners. His learning he decorated with a superior knowledge of the fine arts; and he employed a considerable part of a large revenue in making collection

lections of what was best and most curious in literature and certain branches of the arts. His library is unrivalled in its kind; and his cabinet of prints, drawings and medals, is considered as among the most select and valuable in a country that possesses so many of them.—But to his extensive knowledge and pre-eminent taste must be added the more solid qualities of candour, of liberality, of benevolence; and he presented them all to the world, in which he lived at large, in the form of an accomplished Gentleman, heightened by the unaffected piety of a sincere Christian.

Mr. Cracherode has left a thousand pounds to Christ-Church, Oxford, where he was a student; and his very rich collection of medals, and immense library, to the British Museum.

Lately, at the age of 67, John Strange, Esq. of Portland-place, LL.D. member of the Royal and Antiquarian Societies, and of many of the learned and literary societies of Europe. Mr. Strange was many years British Resident at Venice, where, by his taste and indefatigable diligence; he formed one of the best collections of pictures, particularly of the Venetian school, now in England: his library also is most extensive and splendid. As a naturalist, antiquary, and general friend and promoter of the arts and sciences, his cabinet has always been considered as one of the choicest in the kingdom. By his will he has directed the whole to be sold; his pictures, under the direction of Mr. Wilson of the European Museum, by private contract, after being publicly exhibited; his books, by Messrs. Leigh and Sotheby; his prints, drawings, busts, coins, medals, bronzes and antiquities, by Mr. Christie; his cabinets of natural history, by Mr. King.—Thomas Gould, Esq. his brother-in-law, the Rev. Edward Nares, his nephew, and Mr. Alexander, his solicitor, are appointed trustees and executors.

THE
PHILOSOPHICAL MAGAZINE.

MAR 1799.

I. *Report on the Travels of C. OLIVIER and C. BRUGUIERE, undertaken by order of the French Government, through the Ottoman Empire, Egypt and Persia, during the Years 1792, 93, 94, 95, 96 and 97. Read in the Sitting of the National Institute, February 14th. By C. OLIVIER.*

IN the year 1792 the provisional executive council, sensible of the advantages which might result to commerce, agriculture, natural history, geography, medicine, &c. by a tour through the Ottoman empire, Egypt and Persia; persuaded that these interesting countries had never been considered under a proper point of view, or had been considered only partially, and that we had still much to learn respecting them; made choice of C. Bruguiere and myself to accomplish that object.

After some delays, we at length sailed from Marseilles, in April 1793, in a neutral vessel, and, without touching any where by the way, arrived at Constantinople, after a pleasant voyage, on the 21st of May.

It would be difficult to express the different sensations excited in the traveller by the first view of that large city and

its inhabitants. The mixture of trees, houses and minarets; the canal of the Black Sea, the hills and valleys by which it is bordered, Scutari and the numberless villages situated on its shores, the sea of Marmora with its islands, Mount Olympus covered with snow, the variegated and fertile fields of Asia and Europe, all together present so many pictures which at once delight and astonish. One cannot help admiring the natural beauty of the environs of Constantinople, and reflecting at the same time on the happy situation of that large city, which can be so speedily supplied with provisions; which is so easy to be defended, and which enjoys the advantage of a port so safe, so commodious, and of such an extent. But if we cast our eyes a little farther, we behold the two shores of the entrance into the Black Sea, for the space of several leagues, convulsed by subterranean fires. Different strata of lava, decomposed rocks, porphyry and granites of various colours, more or less altered, attest the slow and successive action of a great volcano. If we ascend a few leagues, we discover, for a vast extent, a mine of coal, which the Turks have not yet found means to work.

We remained six weeks in this capital of the Ottoman empire, waiting till the envoy extraordinary of the Republic should receive from the minister orders respecting our mission and allowance; but the attention of government was at that time engaged with objects of more importance. Our letters remained unanswered, and we should have been thrown into great embarrassment had not our pressing wants been supplied by the envoy of the Republic.

After viewing this country, so interesting in every respect, and making an ample collection of plants, birds, fishes, insects, shells and minerals; and after sending two packages of seeds at different times to the national garden of plants, we set out for the Dardanelles, by which means we had it in our power either to proceed to the Archipelago in the spring, or to return to Constantinople in order to direct our course towards the southern shores of the Black Sea; to proceed
through

through Armenia, Georgia, Ghilan, or Chirvan, to the borders of the Caspian sea; afterwards to traverse Persia from north to south, and to return by the Persian Gulph, Busfora, Bagdad, Mesopotamia and Aleppo. As we did not, however, hear from government, and could receive only a part of our allowance, we confined ourselves to excursions to different places in the neighbourhood of the sea of Marmora, the channel of the Dardanelles, Troade, Tenedos, Scio, some parts of the coast of Natolia, Mycone and Naxia, from which we proceeded to Crete.

Agreeably to our instructions, we had transmitted to Constantinople, to be reared in the garden of the ambassador's palace, plants of a kind of apple-tree with oblong fruit of an excellent flavour, proper to be cultivated in any part of France, but more particularly in the southern departments; plants of three kinds of oak not found in our forests or gardens—one kind proper for ship-building—another *à grand cupule* known in commerce by the name of *avellonnée*, which is the *quercus ægilops*; and lastly, that which furnishes the galls of the Levant: we added also several shrubs destined to enrich the national garden of plants:

Though several well informed Europeans have traversed this part of the Ottoman empire; though many of them have published interesting observations on the political relations of the Turks, their manners, usages, and religion; and though we have excellent works on the plants and ancient history of these countries, we, however, found that there is still an abundant harvest to be reaped, even in the best known part of natural history, that is to say, in regard to plants. But when we reflect that the reptiles, river fish, insects and terrestrial shells in those districts have not been observed by any traveller; that no one has made us acquainted with the riches which the Turks possess in mineralogy, mines of iron and copper, pozzolana, and coals at the very gates of the capital, marble of all kinds exceedingly abundant in the islands of the sea of Marmora and the Archipelago, agates, cornelians,

cornelians and chalcedonies in the fissures of the volcanic rocks, mines of alum and sulphur, mineral waters of every kind; in a word, if we recollect that no traveller has considered this country in regard to geology, that part of natural history so interesting, which by enabling us to observe the different strata of earth and stones, the direction and structure of mountains, and to compare the different fossils that one meets with, must necessarily conduct to a certain knowledge of the antiquity of our globe, of the laws to which it is subject, and of the different catastrophes it has experienced, and of which some faint light has been transmitted to us by the fabulous history of antiquity, will be readily persuaded that our observations, directed to these objects, cannot fail of being highly interesting.

We remained four months at Candia; and though two years had elapsed since our departure from Paris, we had received no intelligence from government. We were, therefore, of opinion, that it would be absolutely necessary for us to renounce our first plans; but as we were desirous of employing our time in the most useful manner possible, we resolved to proceed to Egypt, and to traverse that country so abundant in subjects of observation, and as interesting for the politician and statesman, as for the philosopher, naturalist and antiquarian.

The situation of the French in Egypt was extremely disagreeable: their commerce had been interrupted, and they were in a state of oppression at Cairo. Some of them had been maltreated by the government, and the consul of the Republic enjoyed no consideration. Our first care was to study the monstrous government of the Mamelouks, their military force and their manners; to make ourselves acquainted with the revenues of Egypt, the present state of its commerce, and that which it might be susceptible of under a just and enlightened government. We examined the ports of Alexandria, the road of Aboukir, the Delta, the course of the Nile, its periodical inundation, the canals which the

negligence of the Mamelouks has suffered to be filled up, the monuments reared to gratify the pride of kings, and those which have been constructed in consequence of religious duties. We directed our view, at the same time, to the natural productions of Egypt, and those which might be introduced into it by cultivation; the fertility of its soil, and the diseases to which the inhabitants are exposed. We enquired into the cause of the periodical winds. In the last place we examined whether the plague, that malady so sudden and so terrible in its effects, has its source in Egypt, as some travellers have asserted, or whether it be there only casual and epidemic. Our harvest, in regard to natural history, has been very abundant: we had an opportunity of transmitting to the national garden of plants a third box of seeds from the Archipelago, Candia and Egypt.

On the 23d of March we received letters from the envoy extraordinary, by which he invited us to quit Egypt and to return to the shores of the Bosphorus; because the time was at length arrived for carrying into effect the plans we had formed. "Regions lying farther to the East," said he, "now invite you, and I wish to confer with you before you proceed thither."

Under the same cover there were two letters of C. Desforgues, minister of foreign affairs. One was a copy of that which the minister wrote to C. Descorches; in which he requested from him an estimate of the sums necessary to be expended, in order that we might properly discharge our mission. He authorised him to supply us with whatever sums might be requisite, to procure such guides and information as the nature of our mission required, and to obtain those documents which were indispensibly necessary for our researches and observations. He concluded his letter with the following words: "In all cases these two observers of nature will be subordinate to your commands; they will give you an account of all their operations, and at the end of each month you will transmit to me the result of their
Z 3 observations

observations on the arts, sciences, natural history, commerce, and political state of the countries through which they pass, in order that I may give a faithful representation to the executive council, of their zeal, their labours, and their discoveries."—In the other, the minister informed us, that he had requested C. Descorches to give him an account of the ordinary expences to which we would be subjected. He concluded by desiring us to transmit our submission in writing to C. Descorches, and to conform to the dispositions contained in the letter which he had addressed to him.

We embraced the earliest opportunity of complying, both with the orders of the minister, and those of the envoy. We transmitted our submission; and, having terminated our observations on Cairo and the neighbourhood, repaired, without delay, to Alexandria. We sailed from that port on the 30th of April, and arrived at Constantinople after a navigation of forty-eight days. We had the pleasure of touching at the isles of Rhodes and Lero, which we had not before seen. The repairing of a leak in our vessel obliged us to remain eight days at the former; and we were detained as long at the latter on account of the North winds.

During this interval C. Descorches had been succeeded by C. Verniac. We therefore delivered to the latter a sketch of our operations, from the period of our arrival in the Levant; a statement of the sums we had received; and a minute memoir on the situation of the French in Egypt, the government of the Mamelouks, the productions and revenue of the country, the cultivation of the land, on its commerce, and lastly on the improvements of which the country was susceptible *. This memoir concluded with reflections excited

* The following extract from Norden's Travels, respecting a tradition in Egypt, that the country would be visited by spies, who would report its state, and at last bring a great number of Franks who would conquer it, may amuse some of our readers, and by some will be thought perhaps not inapplicable to C. Olivier's mission, and the events that have followed it:

cited by the order which C. Descorches had given to the consul and French at Cairo, to repair provisionally to Alexandria, and put themselves under the protection of the port captain of the Grand Signior; and to wait there until more favourable circumstances should enable the consul to resume his functions at Cairo, and the merchants their commercial operations. We forwarded to the national garden of plants a fourth box of the seeds from Egypt, Rhodes, Lero, and the shores of the channel of the Dardanelles, as well as a live ichneumon which we had reared for four or five months.

Persia, a prey to the horrors of civil war since the reigns of the latter Sophis (the family of the Sephevi), gave reason to hope for a flourishing kingdom under a monarch who had triumphed over all his rivals, and had destroyed each of them in succession. The opportunity was then favourable

“January 4, 1738.—On this day (Saturday) the Danish traveller, Captain Norden, with his attendants, arrived at Deir, or Derri, the first large village or town in Nubia. The cacheff of that place, a notorious plunderer of all who fell in his power, conducted himself towards the travellers in so infamous a manner, as to oblige the captain to relinquish his design of proceeding further, and return to Cairo. When disputing about some of the exorbitant demands of the cacheff, one of the company reminded him that they were under the protection of the Grand Signior. To which he answered in a passion; ‘I laugh at the horns of the Grand Signior: I am here Grand Signior myself, and I will teach you to respect me as you ought. I know already what sort of people you are. I have consulted my cup; and I have found by it, that you are those of whom one of our prophets has said: That there would come Franks in disguise, who, by little presents, and by soothing and insinuating behaviour, would pass every where, examine the state of the country, go afterwards to make a report of it, and bring at last a great number of other Franks, who would conquer the country, and exterminate all. But I will take care about that; and without further delay you must quit my bark.’ After being plundered by him, in various ways, till the evening of the following Monday, the travellers thought themselves very fortunate in being permitted to escape with their lives.—[*Dr. Templeman’s Translation of Norden’s Travels*, 8vo. edit. 1757, vol. ii. p. 150.] EDIT.

for travelling into the interior parts of this country, so interesting in every point of view. C. Verniac allowed us the whole of our appointment, authorised us to engage a dragoman, gave us a letter to the chief minister of the king of Persia, another to the pacha of Bagdad, and, at the same time, various instructions both verbally and in writing.

At the moment of our departure, the Porte had a design of constructing in the harbour of Constantinople a basin after the model of that of Toulon; and some Armenian merchants wished to prevail on us to communicate to them a discovery we had made of an excellent kind of pozzolana, by offering us the sum of 30,000 piastras. As we were here under the orders of the Republic, we did not think ourselves at liberty to enter into any treaty with Armenians, in regard to our discoveries, until we had apprised the envoy of the Republic. C. Verniac, who intended to get this basin constructed by French engineers, desired us to reject the offers of the Armenians, promising to procure us a more ample recompence from the Porte; and he immediately sent the first dragoman of the legation to the Turkish government, to communicate our discovery, and make an offer of our services. The Porte seemed to accept this offer with gratitude; and having requested a note on the subject, we embraced the earliest opportunity of transmitting to it a memoir, in which we said that we had discovered pozzolana of an inferior quality near the channel of the Black Sea, in Prince's islands, and various islands of the Archipelago; and some of a superior quality, or at least equal to that of Italy, in the island of Santorin. The memoir concluded with a few details respecting the method of employing both.

The ministers of the Porte, when they received this memoir, informed the dragoman, that the Armenians had demanded for the discovery 60,000 piastras, though they had offered us only 30,000. They added, that they would never forget the service which we rendered to them, and that their gratitude would be boundless if we could effect what we promised.

promised. On this subject we had two interviews with the Chelebi-Effendi; and that minister twice gave us reason to hope that the Porte would reward, in a manner worthy of itself, the important discovery we had communicated.

In the mean time we were just on the point of proceeding on our journey to Persia. The necessary preparations were already made, and we were looking out for a caravan going to Diarbekir, when the Porte required that we should repair to the isles of Santorin, Milo, and Argentiera, and transmit to it some bags of pozzolana, in order that previous experiments might be made. For this purpose it freighted a French vessel, and sent a chiaous to accompany us and bring back the specimens. We were obliged to touch at Metelin to receive from the captain pacha, then lying at anchor before that island, the necessary firmans.

The inhabitants of Santorin, alarmed at this discovery, and fearing that the Ottoman government would cause the earth to be dug up at their expence, and of course send Turkish officers into the island, immediately assembled to execute the Grand Signior's orders, and to devise means for warding off the blow with which they were threatened. They thought they could do nothing better than to send the primates to the Latin bishop at whose house we lodged, and to offer us a present if we would inform the Porte that we had discovered none of the above substance in the island. We, however, rejected the offer of these primates, and transmitted to Constantinople several bags filled with pozzolana of an excellent quality, which was in great abundance, and exceedingly easy to be dug up. We depended on C. Verniac for the promised recompence to which we thought ourselves entitled by the importance of the discovery, by rejecting the offers of the Armenians, and the trouble, dangers, and delay we had experienced.

The island of Metelin, almost entirely volcanic, is remarkable on account of its great fertility, its immense ports, and its warm mineral springs. Argentiera, known formerly
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under the name of Cimolus, is entirely volcanic. We remarked, with pleasure, that the Cimolean earth, which it furnishes in abundance, is produced by a slow and gradual decomposition of the porphyries occasioned by subterranean fires. I collected specimens of that earth in all the states through which it passes. This observation will be interesting, no doubt, to mineralogists, and make them acquainted with the origin of a substance hitherto little known. The island of Milo is altogether volcanic. It presents a vast port, on the borders of which is a spring of warm aluminous water; a very warm grotto, where feather alum is formed; a volcano still burning, and a prodigious quantity of catacombs. The island of Santorin is remarkable for the changes effected in it by a volcano, and the sinking down of a great part of the island; from which has resulted a kind of port, more than two leagues in extent, and from the bottom of which three isles have been thrown up at different known periods. The rupture occasioned by the almost circular sinking down of the island exhibits different strata of volcanic substances, among which we observed several kinds of pozzolana. That which we sent to Constantinople, and of which I have specimens, may one day serve for such maritime constructions as the French may think proper to make in Egypt, when they are once firmly established in that country.

We touched a second time at Rhodes, proceeded thence to Baruth, and afterwards to Sayd, with a view of going to Damascus to take advantage of the departure of a caravan for Bagdad, as we had been taught to expect; but, the caravan having departed a long time before, we were obliged to return and take the route to Aleppo. We were unwilling to quit the coast of Syria without paying at Tyre a tribute of admiration to which that city was so justly entitled.

As the road from Latakia to Aleppo is never safe, we waited some days for the departure of a caravan. During that time we transmitted to the national garden of plants
a fifth

a fifth box of seeds, from the islands we had visited, and the coasts of Syria. On our arrival at Aleppo we employed ourselves in examining the situation of the French in that city. We collected information respecting the commerce carried on by the Europeans with the inhabitants, and sent to C. Verniac a memoir on that subject. We also made various observations in regard to natural history and geology. We procured several birds, and a few quadrupeds: after which we set out, towards the end of winter, in company with a caravan; and, passing through Orfa, Merdin, Nesbin, and Mosul, arrived at Bagdad without any accident.

(To be concluded in the next Number.)

II. *Process of making Attar, or Essential Oil of Roses.* By
Lieut. Col. POLIER. *From the Asiatic Researches.*

THE attar is obtained from the roses by simple distillation, and the following is the mode in which I have made it.

A quantity of fresh roses, for example forty pounds, are put in a still with sixty pounds of water, the roses being left as they are with their calyxes, but with the stems cut close. The mass is then well mixed together with the hands, and a gentle fire is made under the still: when the water begins to grow hot, and fumes to rise, the cap of the still is put on, and the pipe fixed; the chinks are then well luted with paste, and cold water put on the refrigeratory at top: the receiver is also adapted at the end of the pipe; and the fire is continued under the still, neither too violent, nor too weak. When the impregnated water begins to come over, and the still is very hot, the fire is lessened by gentle degrees, and the distillation continued till thirty pounds of water are come over, which is generally done in about four or five hours: this rose-water is to be poured again on a fresh quantity (forty pounds) of roses, and from fifteen to twenty pounds of

water

water are to be drawn by distillation, following the same process as before. The rose-water thus made and cohobated, will be found, if the roses were good and fresh, and the distillation carefully performed, highly scented with the roses. It is then poured into pans either of earthen ware or tinned metal, and left exposed to the fresh air for the night. The attar, or essence, will be found in the morning congealed, and swimming on the top of the water; this is to be carefully separated and collected, either with a thin shell or a skimmer, and poured into a phial. When a certain quantity has thus been obtained, the water and fæces must be separated from the clear essence, which, with respect to the first, will not be difficult to do, as the essence congeals with a slight cold; and the water may then be made to run off. If, after that, the essence is kept fluid by heat, the fæces will subside, and may be separated; but if the operation has been neatly performed, these will be little or none. The fæces are as highly perfumed as the essence, and must be kept. After as much of the essence has been skimmed from the rose-water as could be, the remaining water should be used for fresh distillations, instead of common water, at least as far as it will go.

The above is the whole process of making genuine attar of roses. But as the roses of this country give but a very small quantity of essence, and it is in high esteem, various ways have been thought of to augment the quantity, though at the expence of the quality. In this country, it is usual to add to the roses, when put in the still, a quantity of sandal-wood raspings, some more, some less, (from one to five tolaks, or half ounces). The sandal contains a deal of essential oil, which comes over freely in the common distillation; and, mixing with the rose-water and essence, becomes strongly impregnated with their perfume: the imposition however cannot be concealed; the essential oil of sandal will not congeal in common cold, and its smell cannot be kept under,
but

but will be apparent and predominate in spite of every art. In Cashemire they seldom use sandal to adulterate the attar ; but I have been informed, to increase the quantity, they distill with the roses a sweet-scented grass, which does not communicate any unpleasant scent, and gives the attar a clear high green colour : this essence also does not congeal in a slight cold, as that of roses. Many other ways of adulteration have been practised, but all so gross and palpable that I shall say nothing of them.

The quantity of essential oil to be obtained from the roses is very precarious and uncertain, as it depends not only on the skill of the distiller, but also on the quality of the roses and the favourableness of the season : even in Europe, where the chemists are so perfect in their business, some, as Tachenius, obtained only half an ounce of oil from one hundred pounds of roses.—Homberg obtained one ounce from the same quantity ; and Hoffman above two ounces.—The roses in those instances were stripped of their calyxes, and only the leaves used. In this country nothing like either can be had ; and to obtain four masahas (about one drachm and half) from eighty pounds, which, deducting the calyxes, comes to something less than three drachms per hundred pounds of rose-leaves, the season must be very favourable, and the operation carefully performed.

In the year 1787 I had only sixteen tolahs, or about eight ounces of attar from fifty-four maunds, twenty-three seers (4366lb.) of roses produced from a field of thirty-three biggahs, or eleven English acres, which comes to about two drachms per one hundred pounds.

The colour of the attar of roses is no criterion of its goodness, quality, or country. I have had, this year, attar of a fine emerald green, of a bright yellow, and of a reddish hue, from the same ground, and obtained by the same process, only of roses collected at different days.

The calyxes do not in any shape diminish the quality of the attar, nor impart any green colour to it, though perhaps

haps they may augment the quantity : but the trouble necessary to strip them must, and ought to, prevent its been ever put in practice.

III. *On Primary Ores of Iron.* By Mr. DAVID MUSHET,
of the Clyde Iron Works. Communicated by the Author.

PRIMARY ores of iron are so named in contradistinction to ores which appear, like iron-stones, to have been formed by a secondary agency. Their varieties are still more numerous than those of iron-stones; possessing various characteristic features, which amply distinguish them from each other, either in their inherent properties and effects, or in the manner of their fossil disposition. Some are obedient to the magnet, others not. This property is by no means dependent upon the quantity of iron existing in the ore: the ore from the island of Elba, some of which yields 70 to 80 per cent. of iron, is slightly obedient to the magnet: the fine hæmatites and kidney of the Cumberland ore, which yield from 64 to 70 per cent. are not, in their native state, in the least degree magnetic; while many of the Danish and Norwégian ores, containing from 18 to 30 per cent. are magnetic in a great degree. I have formerly mentioned, that where the magnetic property was inherent, it was more a proof of the existence of iron, than a criterion whereby to judge of the probable quantity of metal in the ore:

The colours which primary ores of iron exhibit are also very various. The beautiful crystallised fractures of the Elba specimens, the prismatic colours they exhibit, the coloured oxyde deposited in flowers upon their surface, and the general appearance which they have of fusion, strongly lead to a conclusion that fire has here been the immediate agent in the production of such variegated forms. This conclusion is still more forcibly impressed, after minutely examining and comparing with them those very perfect crystals which are found

amongst the Cumberland ores. These at once convey the idea of the agency of water in their formation: if the internal cavities of some of the pieces are examined, the proofs multiply and become irrefragable. The chasms in which the crystals are found, and always formed, display the process of crystallization in all its various stages. Crystals are found in finish and form proportioned to the stage of the operation: some imperfect, and of a clayey consistency and colour; others in a more finished state, hard, but as yet unpolished or diaphanous: some are encircled in a slimy membrane, which, when displaced, displays the crystals more or less transparent as the operation has been more or less perfect. I have found cavities in this ore quite filled with water, which in this state had been transported some hundred miles; the sides and bottoms of such chasms always abounding with a soft mud composed of the finest fragments of *filex*, free from every touch of asperity. Again, crystals are found in this ore, which possess various degrees of pellucidity; some of them very white, yet dull; absorbing light, yet transmitting little. Others are as clear and transparent as the purest water; their angles frequently decomposing light with all the vivid effects of the prism. Other varieties are less diaphanous, but possess various tinges of colour, and increase in opacity in proportion as the colouring matter is present in the crystal. Some possess a garnet colour more or less intense, and most of them transmit less or more light.

There is another variety of crystals among the Cumberland ore, exhibiting a green colour, which is owing to the presence of an acid. This, like the garnet coloured crystal, transmits light in a greater or lesser degree in proportion to the quantity of iron present. There are also various prismatic crystals in this ore, of a small size, which owe their splendid and variegated lustre to sulphur, and which are easily tarnished by the application of heat. Specimens also of crystallized iron ore, in the form of razor blades, containing oxygen and carbon, are not uncommon: these resemble more the Elba ore than

than any other variety; yet, the state of the carbon so much resembling fossile plumbago, so unlike the carbon which the Elba specimens afford, and so widely different from that obtained by fusion, together with the smallness and regularity of the crystals, their lustre and finish constitute a wide difference between these two ores.

The fine red oxyde which so much resembles cinnabar, and which is found in abundance upon the Elba iron ore, appears to me to be an oxyde of iron deposited by the decomposition of sulphat of iron. Thus far I can say, that a powder exactly similar was deposited upon the surface of some iron-stones exposed to a high temperature, in which I had ascertained the presence of the sulphuric acid. The various shades of colour which appear upon the Elban ore, exactly resemble those which may be passed upon ore, iron, or steel, by exposing them under certain degrees of heat to the action of atmospheric air. Its fracture is most evidently vitrified, and exactly resembles iron fully combined with oxygen, afterwards reduced by fusion to an opaque and very ponderous glass. Like the Elban ore, such vitrifications, when broken, display a perfect state of crystallization.

I have even obtained specimens of this ponderous lava possessing a variety and richness of colouring, equal to many of the Elban specimens.

Though the agency of water will more readily explain the structure, crystallization and deposition of fossils in general, yet there are circumstances which most forcibly claim an exception. The Elba ore, in my opinion, is one: I conceive it to be iron oxydated in fusion by the combination of a quantity of oxygen, from 18 to 24 per cent. inclusive of a small portion of carbon, to which, either at the time, or by a subsequent process, some volatile mixtures have been added. In a more proper place I shall minutely enter into the nature and analysis of this beautiful ore of iron. I shall only here exhibit some simple results obtained from it when comparing it with other ores of iron.

The form and appearance of the mass of this ore much resembles the excessively saturated specimens of crude iron and plumbago, described in my paper upon the principles of iron and steel, with an allowance in the former for its long exposure to the tarnishing effects of water and other elements: the agency of these has conferred a variety of colours in flowers, though the principal colouring of the ore seems to have been the effects of oxygen combined with the iron at certain degrees of heat: in its raw state the magnet has little power over it. Of this ore pulverised (which possessed a fine reddish brown colour, interspersed with shining specula of magnetic iron ore, resembling plumbago produced in the smelting furnace), I threw into an iron vessel heated to redness 80 grains: a gas was disengaged, which, from its smell, I concluded was carbonic acid gas, for I had not at hand a proper apparatus or lime-water to try it with: the ore deepened during ten minutes exposure, without changing the splendor of the small specula; when cooled, it was found to have lost 2 grains = 2.25 per cent.

I next introduced into a close vessel, in small pieces, 315 grains, and exposed them to torrefaction for four hours in a bright red heat: the residue weighed 282; so that there were lost of carbonic acid, and perhaps a little water, 33 grains = 10.7 per cent. The fine red, brown, and purple colours, were now totally annihilated; a slightly coloured powder was attached to the stopper of the vessel; the ore was now of a dull blueish colour, much frittered, granulated, but not pulverulent: the magnet in this state possessed a considerable degree of influence over it, but by no means in proportion to the quantity of iron which it contained—not even equal to what it has on common iron-stones: from this circumstance I inferred, that a considerable quantity of oxygen still remained fixed with the metal. In order to ascertain this, I introduced the last product, weighing 282 grains, into a close vessel, mixed with charcoal dust: the mixture was exposed for nearly ten hours to a bright red heat; the ore being then se-

pared from the charcoal, washed and dried, weighed 222.5, the charcoal having taken up 59.5 grains = 21 per cent.

In this state the ore had lost all its colour, and had assumed a whitish limey tinge; had increased in bulk, and become frittered, yet possessing a considerable degree of continuity: when the smallest degree of friction was applied, the metal brightened, and shewed a beautiful disengaged state of malleable iron; the pieces easily connected under a welding heat, and received with facility impressions from the hammer; it now adhered in great abundance to the magnet. The small portion of lime, nearly equal to two parts, which was still interspersed with it, effervesced in acids; but the iron remained without exciting agitation. The practical analysis of this specimen of the Elba ore may, for the present, be thus stated:

Water, carbonic acid, and other volatile mixtures, driven			
off by torrefaction	-	-	10.7
Oxygen (taken up by the charcoal)	-	-	21.2
Lime	-	-	2
Iron	-	-	66.1
			<hr/>
			100 parts.

The specific gravities of the various states of this ore are as follows:—In the raw state, 4.317—Torrefied, 4.000—De-oxygenated, malleable, much frittered, 2.460.

In the subsequent part of this paper, I shall confine myself chiefly to those primary ores used in Britain for the production of crude iron. The effects produced by such ores, when fused alone, are only to be learned in this country, at those iron-works where the charcoal of wood is used. The number of charcoal furnaces however are decreasing; and those at present used as such, are not supplied with wood for one-third of the year. These ores are, in the charcoal furnace, capable of producing crude iron of all the various degrees of carbonation. Since the invention of coak pig-iron, the proprietors of these furnaces have confined their manu-

facture

facture to the forge pig, or oxygenated crude iron, part of which is used to make a fine quality of bar-iron for the purpose of manufacturing into wire: for this end some of the manufacturers prefer carbonated iron, from which to fabricate their bars, in order that a great share of ductility, elasticity and strength may conjointly be united. British bar-iron, thus manufactured, far exceeds the finest foreign marks, in its astonishing ductility in the wire-drawer's gauge.

When primary ores of iron are introduced into the pit-coal blast furnace, forming by weight a considerable proportion of the mixture, with the usual proportion of coaks, the result is always oxygenated crude iron, unfit for any purpose but the forge manufacture. Experience, therefore, has taught the smelter to use them in small quantities, proportioned to the measure of iron-stone applied at each charge of materials. Some have renounced the use of Cumberland and Lancashire ores, as being incompatible with the existence of good melting pig-iron; and the advocating for or against their use is at present a matter of local opinion. So much is, however, decided regarding them, that primary ores of iron in any proportion will, when improperly applied, produce oxygenated crude iron; that iron-stone, properly proportioned with coaks, affords the finest quality of crude iron; and, in the iron trade, it is still a desideratum, whether Cumberland and Lancashire ores, when smelted with pit-coal, will afford in the large way a quality of pig-iron equal to that presently made from iron-stone. On this interesting subject I shall make a few observations. I deem it interesting, since, in many places on the coast of Scotland, coal is to be found in great quantity, where as yet a sufficient quantity of iron-stone has not been discovered, or which from appearances likely never may: in such situations, favoured by a ready communication, either to import materials, or to vend raw or manufactured products, the Cumberland and Lancashire ores might be purchased and used with great econo-

my, provided the great end could be answered of obtaining from them crude iron of all the various degrees of carbonation.

These ores, either in a raw or *calcined* state, being much richer in iron—nearly double—than the average mass of iron-stones, are in the blast furnace more fusible, from their superior richness; they descend so rapidly to the bottom of the furnace, through the strata of ignited coaks, that time is not given for imbibing the carbonic principle; part of the iron is separated highly oxygenated, and part of it runs off precipitated in oxygen, and united with the scoria or fused earths. When this is found to be the case, and which is easily known by the fracture, weight, and blackness of the lava—were the manufacturers to add a farther proportion of fuel to take up the remaining oxygen, then the whole, or nearly the whole of the metal would be revived; still it would possess a white fracture. Were the Cumberland and Lancashire ores solely used with pit-coal, were they deprived of their iron, and again that iron revived, though possessed of a highly oxygenated fracture, the great object would be half effected; for it is obvious, that in this case the furnace, and the quality of iron, are in the same state with a blast furnace, affording a similar quality of metal where iron-stone and pit-coal coaks only are used. In the latter case a small additional portion of fuel, per charge, enables the metal to take up a part of the carbon afforded by the fuel: the fracture of the metal is, by this combination, or mixture, changed from white to grey blue; its assumption of this colour is in proportion to the extra quantity of fuel. From this fact, and from the parity of situation, I conclude that by a similar treatment—the additional fuel being always proportioned to the weight of metal in the ore—the metal of such ores might be revived sufficiently carbonated for any purpose; though, I question not, possessed of peculiar characteristic properties, which would distinguish this metal, in a greater or less degree, from that obtained from iron-stones treated in the same manner.

Accustomed to apply the ores by weight, a determinate quantity is frequently introduced into the furnace without adverting to its superior richness in iron, and the consequent extra proportion of fuel necessary to take up its relative proportion of oxygen. The nature and consequences of this will be better understood by the following example; first premising, that the quantity of oxygen—which is the great evil to be got rid of—exists in a just proportion to the quantity of iron. Suppose then a blast or smelting furnace, burdened in the following manner as to coaks and iron-stone: Coaks 400 lb.—Torrefied iron-stone of various qualities $420 = 820$: let this quantity be supposed to yield in the blast furnace 40 per cent. then each charge will yield 168 lb. Let it also be supposed that this proportion of materials afforded super-carbonated iron; in this case there was present, not only a sufficient quantity of carbon to take up the oxygen contained in the ore, but such an abundance as to unite with the iron and to form plumbago. Should it be wished to reduce the quality, or to increase the quantity of the pig-iron, by rendering it less carbonated; and should this be effected by adding to the above mixture a small box of Cumberland ore containing 60 lb., then a portion of iron, with its accompanying oxygen, (supposing the ore to yield in the blast furnace 55 per cent.) would be thrown into the furnace equal to 33 lbs.; and the total produce of iron, per charge, would be $168 + 33 = 201$ pounds, making a sum nearly equal to $\frac{1}{5}$ of the original quantity. This portion would of course require $\frac{1}{5}$ of additional fuel to preserve the original quality of the metal: it is even presumable that the proportion of coaks increases in a greater ratio, owing to the speedy descent of the ore through the furnace: this increase may be fairly estimated as 5 to 8. The quantity of fuel being now too little to take up all the oxygen, part of the metal remains unrevived, and flows out, minutely divided, and interspersed through the scoria, in the state of an oxyde; the separated metal, deprived of its original portion of char-

coal, issues from the furnace highly oxygenated—a number of globules deflagrating so soon as it comes in contact with the air.

If, in order to correct the quality of the iron, a portion of the iron-stone is taken off = 1 box, or 60 lb. let the produce of this weight be estimated at 40 per cent. then the quantity of metal taken from the total 201, will be equal to 24, leaving for metal produced at each charge 177 lbs. instead of 168, as in the former case when the iron was super-carbonated.—Additional quantity of metal = 9 lbs.

Quantity of concrete oxygen, reckoned at 22 per cent. nearly equal to 2 pounds weight.

Small as this quantity may appear to be, yet, on many occasions, a furnace will not admit of the addition without altering the quality of its iron from the one extreme to the other. The manufacturer, therefore, finding his operation with ores so subtle and precarious, frequently abandons their use, in the firm belief that their application, in quantity, is incompatible with the existence of good melting pig-iron; whereas, had the ore received a proportion of fuel adequate to its superior richness, it is at least questionable whether the exact same consequences would have been entailed: even in the case of iron-stones, the manufacturer ought to consider the quantity of iron contained in the ore, as also the nature of the various mixtures, in order to ensure to himself a produce of carbonated crude iron.

There are two ways which would most likely be attended with the happiest effects in producing melting pig-iron from primary ores of iron with pit-coal, advantageous to individuals, and to the improvement of the business in general: the one, by a process similar in its principles of preparation to that at present practised for iron-stones; the other, by de-oxygenating the ore before it is introduced into the blast furnace. To ensure success in the former of these operations, the following requisites would be necessary.

1st. A narrow constructed furnace, of an unusual height, in

descending through which, the ore, previous to fusion, would be exposed to a long cementation in contact with the coal; by which means the carbonaceous or fusible principle would be conveyed to the metal in quantity, and its quality thus constituted previous to separation.

2nd. The column of air necessary in this case would require to be cool, dense, and quickly impelled; the diameter of the discharging pipe not to exceed $2\frac{1}{4}$ inches, but the column of blast able to support 6, $6\frac{1}{2}$, or 7 inches of mercury.

3rd. In the application of the ore itself great attention ought to be given to the quantity of iron contained, as also to the quantity of oxygen combined with it, in order that a quantity of coaks might be applied adequate to what a similar portion of iron would require in using iron-stone.

4th. The ore should be dried in a red heat, that what portion of water and sulphur it contained might gently be dissipated; care to be taken, however, to prevent a high degree of heat, that a greater quantity of oxygen from the atmosphere might not be united to it.

5th. It would be highly proper to reduce the ore to small pieces: this would not only greatly facilitate the escape of the water and sulphur by diminishing the points of contact, but also, by exposing a larger surface, enable the ore in the smelting furnace to take up the coally principle with greater facility; the pieces not to exceed $\frac{1}{2}$ or $\frac{3}{4}$ of an inch in their thinnest diameters.

6th. The earthy mixtures of ores being chiefly siliceous, the application of pure calcareous earth as a flux or solvent would be requisite; and, according to existent circumstances, a lime-stone, containing fine clay, slightly coloured by the presence of the oxyd of iron, might be used: the bulk of the pieces of lime-stone ought also to be a matter of attention, and should not greatly exceed the ore in size.

In the end, should an association of these requisites produce the desired effect, and crude iron of all the various degrees of carbonation be obtained from primary ores of

iron, it would render many situations in this country eligible for iron-works, which are at present only so on account of the immense profusion of coal with which they abound; it would call into profitable existence the iron contained in these vast and extensive mines of Cumberland and Lancashire; confer spirit and activity on the manufacturer and the landed proprietor, in a general search after so profitable and useful a mineral; and would tend to throw new and ample light upon many valuable ores of various natures, which at this time lie dormant, unexplored, and unappreciated.

The second method likely to succeed in fabricating melting pig-iron from primary ores would be to subject them to de-oxygenation in the most economical way; not severely, so as to change them into malleable iron, but in a manner which would still render them sufficiently fusible. The deprivation of oxygen in this manner, would enable the carbonaceous principle to take immediate effect, by penetrating the ore, and constituting real fusibility: it is even probable that the quantity of fuel used to effect this, in such simple constructed furnaces as might be found answerable, would afterwards be saved in the smelting furnace, and the ore rendered equally cheap in this state as when raw—besides the great point in obtaining the wished for quality of iron.

The coaly matter requisite to stratify the ore—previous to de-oxygenation—would be the dust afforded by the coals in the present mode of coaking; and which, from the tender nature of the coal, exists, at some works, in great quantities: it is of no real value, and, by passing it through sieves to render it of an equality of size, it might be used to imbed the ore without any other preparation. Such matter as this is capable of protecting the ore for a much longer time than would be requisite in this operation: charcoal-dust, made from pit-coal, is capable of withstanding a heat equally violent as charcoal-dust from wood, without being sooner consumed; it is even less liable to be destroyed when at

any time in contact with external air, either in the process of cementation for steel, or in the de-oxygenation of iron-ores. Iron-ores thus stratified, exposed to a state of complete ignition, would in 8 or 10 hours nearly part with the whole amount of mixtures, including oxygen, with which they were combined; the ore would be found penetrated with a considerable portion of carbon, and the metal existing in a state nearly disengaged. Their tendency, however, would much depend upon the various mixtures which composed the individual ores; their loss of weight, their properties and appearance, also depending upon similar circumstances with those explained in the preparation of iron-stone in a former paper.

The varieties of the primary ores of iron found in this country are much limited, and chiefly possess the same external characteristic forms—at least those which have come within my knowledge—that of the island of Islay excepted. Cumberland and Lancashire seem to be the two great deposits for this mineral. The ore of the former is found in large masses, splinty, and globulated, consisting of various kidney forms and hæmatites, striated and smooth, of blueish and reddish colours. The kidneys are frequently large, composed of successive layers encrusting a nucleus of coarser ore. The splinty pieces are of a light blueish colour, and frequently afford the most beautiful specimens of various crystals, principally of a whitish colour, of a chalky, and sometimes of a pellucid appearance; also garnet, more or less intense, and green. The most common shapes are pentagonal and hexagonal pyramids, with truncated bases. Some of these I have found measure 1 inch at the base: from this uncommon size, down to the most minute forms imaginable, the same figures are found possessing purity, transparency, and finish in the highest degree: these classes are of a whitish water colour, more or less pellucid. Garnet coloured crystals are found of the same shape, but of a very small

small size, none of them measuring more than $\frac{1}{20}$ of an inch upon the base.

The various shades of garnet, yellow, and green coloured crystals, when found of a large size, have generally assumed the form of a prism, a cube, or a parallelopipedon with flattened edges: none of these, however, possess the transparency of the pure quartzose crystal. The whole of these forms are found in chasms in the large masses of splinty ore: when the cavity is broken up, the groups of crystals are found occupying all its sides, and projecting their tops to each other. Not unfrequently clusters of crystals are found imbedded in a thin stratum of beautifully crystallised prismatic iron-ore, obedient to the magnet, and possessed of the most splendid dazzling colours.

The Lancashire ore is composed of smaller masses, softer, and of a more greasy appearance; there are, however, in it all the former variety of crystals, though of a smaller size. The quality of this ore is also much preferred in the blast furnace, whether in the process with pit-coal coaks, or with the charcoal of wood. This partiality is owing to the mixtures in it being more favourable to the existence of carbon in the blast furnace: clay, and not unfrequently calcareous crystals, are found in this ore; whereas the earthy mixture of the Cumberland ore is chiefly siliceous, with a small portion of sulphur. Both of these ores, in the kidney variety, contain fine specimens of fossil plumbago.

In several places in Scotland iron ores have been discovered resembling in point of appearance those of Cumberland and Lancashire: some individual pieces as rich in iron, but the average quality, as to contents in iron, inferior. The quantity hitherto found has been so small, and its locality so insulated, that it has never been, to the manufacturer, an object of attention, nor of farther search to the proprietor. In the West Highlands some transient veins have been found, but their irregularity of disposition has

hitherto

hitherto prevented their source, or principal mass, from being explored.

A vein, which indicated a large field of supply, was some years ago traced in the neighbourhood of Muirkirk iron-works, and its course followed for several miles. The kidney pieces of this ore are fully as rich and ponderous as those of the Cumberland vein.

Salisbury Craggs, in the neighbourhood of Edinburgh, afford also some very good specimens of an irregular vein, which still remains untraced; apparently the same ore is found on an estate belonging to the family of Dundonald, called La Mancha, 10 miles south of Edinburgh; the lands of Cranston also afford a similar ore: the quality of the ore, in both of these places, may be reckoned upon the average to yield 42 per cent. of iron.

I have seen some very fine specimens of iron-ore picked up in different parts of Fifeshire, where no vein could possibly be discovered.

The finest Scotch ore I have seen, and which possesses mixtures congenial to the existence of carbon in the blast furnace, is found in the Ochil-hills, not above two miles from the Devon iron-works. This ore is soft, loosely stratified, of a reddish colour, not very ponderous; but possessing a superior quantity of iron.

The iron ore of the island of Ilay is found regularly stratified, and resembles, in point of deposition, the Norwegian and Danish ores. The strata are almost vertical, and are found imbedded in a loose ochreous earth surrounded with soil: the fracture of this ore partakes of the nature of the imbedding earth; it abounds with shining specula resembling filex, but which, upon closer examination, prove to be plates of slightly magnetic iron-ore.

Having thus shortly enumerated some of various indications of the existence of iron-ore in Britain, I shall subjoin the treatment of two of them widely different in their fossil deposition, their appearance, and their component parts; these

these shall be, the ore of the island of Iſlay, and the Cumberland iron-ore.

Of the former I pulveriſed 872 grs. which I threw into an iron veſſel of a red heat. In $1\frac{1}{2}$ minutes, during which time no ſenſible ſmell was diſengaged, the powder aſſumed a complete change of colour, and loſt in weight 12 grs. The ore was again returned into the furnace, and expoſed to a bright red heat for 5 minutes, in which time it loſt farther 28 grs. —in all 40 grs. = 4.58 per cent.

I next reduced to ſmall pieces 2700 grs. of this ore, and ſubjected them to a high heat for 8 hours, partially expoſed to air, in which time 314 grs. of volatile mixtures were driven off, equal to 11.2 per cent.

The ore had now aſſumed a reddiſh blue colour; had become friable, and much divided; it parted in ſmall granulated maſſes, like the fragments of quartz, but was conſiderably magnetic. The fracture was rough, full of aſperities; it did not efferveſce with acids, nor had it acquired any ſenſible increaſe of weight; when pulveriſed, the ſhining ſpecula were moſt conſpicuous, and very magnetic. Some of their ſurfaces, by avoiding the one pole of the magnet, and embracing the other, led me to ſuppoſe they had polarity. In order to de-oxygenate this ore, I introduced 2040 grs. in ſmall pieces, mixed with charcoal, into an iron teſt luted with clay, and expoſed the mixture to a high red heat for ten hours: the ore then ſeparated from the charcoal, and weighed, was found to have loſt, of volatile mixtures and oxygen, 456 grs. = 22.3 per cent.; from which deducting 11.2 as the quantity of volatile mixtures, being the quantity loſt by ſimple torrefaction as ſtated above, there remains 11.1 per cent. for oxygen taken up by the charcoal.

In this ſtate the ore had aſſumed a blueiſh colour; had become bulky and pulverulent, without exhibiting the ſmalleſt ſign of malleability: it was, however, ſo completely de-oxygenated, and the metal ſo much revived, as to deſlagrate with the rapidity of iron filings.

I next

I next exposed of this ore in small pieces to a similar temperature, in an open vessel, - - 1804.2 grs.
After eight hours the fragments weighed - 2260

Gained in weight, by the combination of oxygen, 455.8 grs. equal to 25.2 per cent. of de-oxygenated ore, and to 19.6 of raw ore.

The magnetic virtue so eminently manifested in this ore was now totally lost, and the individual pieces had acquired a sensible increase of weight. From this ore I obtained, by fusion, a button of oxygenated crude iron, equal to - - - - 56.5

Oxygen taken up, as above - 11.1
Water of crystallisation - 11.2
Earths, chiefly flint and clay, - 12.2

100 parts.

The specific gravity of this specimen I found to be—in a raw state, 3.370; de-oxygenated, 3.060; oxydated and combined with 25.2 per cent. oxygen, 4.000.

Of the many experiments I have made upon the Cumberland iron-ore, the following, at the present time, may serve as a comparative treatment with others. Of this ore, pulverised, I threw into a red hot vessel - 218.5 grs.
Instantly a blue flame arose, and hovered nearly half a minute upon the surface of the powder: the smell was sulphureous, penetrating, and strong: the powder, after 5 minutes, was taken out, and weighed - 212.5

Lost of water and sulphuric acid - - 6 grs.
The colour was considerably deepened; and the mass had acquired a minute portion of magnetic obedience.

I next torrefied, of this ore, in an open test, - 2086 grs.
After a bright heat of eight hours, the residue weighed - 1961

Total loss of water and sulphur - 125 grs.

In order to de-oxygenate this ore, I introduced, mixed with charcoal, into an open vessel, - 2894 grs.
 This mixture was exposed, under a high heat, for ten hours : when the ore was separated from the charcoal, it weighed - - 2069

 Total loss of volatile mixtures = 28.5 per cent. 825 grs.

In this short time the whole mass had become malleable, highly polished, and was finely converted : when heated, the pieces welded together, and were easily drawn into small rods of good malleable iron.

In another experiment I exposed, of the de-oxygenated ore, to a still higher degree of heat than the former, 1841.5 grs.

The mass, when cool, weighed - 2489

Gained in weight, by the combination of oxygen, 647.5 grs. equal to 35.16 of de-oxygenated ore, or 25.14 of raw ore.

The practical analysis of this species of the Cumberland ore (a mixture of kidney and hæmatites) may be thus stated :

Carbonated crude iron obtained in the assay	
furnace - - - -	64.5
Water and sulphur - -	6
Oxygen taken up - -	22.5
Earths, chiefly filex, - -	7
	<hr/>
	100 parts.

The specific gravities of the various states of this specimen I found to be—in a raw state, 4.6623 ; de-oxygenated, and malleable, 6.3000 ; combined with oxygen, 5.1900.

IV. *Description of the Lácsha, or Lac Insect* *. By Mr. W. ROXBURGH, Surgeon on the Madras Establishment. Communicated by Dr. JAMES ANDERSON. From the Asiatic Researches.

SOME pieces of very fresh-looking Lac, adhering to small branches of *Mimosa cinerea*, were brought me from the mountains on the 20th of last month. I kept them carefully, and to-day, the 4th of December, fourteen days from the time they came from the hills, myriads of exceedingly minute animals were observed creeping about the lac, and branches it adhered to, and more still issuing from small holes over the surface of the cells: other small and perforated excrescences were observed with a glass amongst the perforations, from which the minute insects issued, regularly two to each hole, and crowned with some very fine white hairs. When the hairs were rubbed off, two white spots appeared. The animals, when single, ran about pretty briskly, but in general they were so numerous as to be crowded over one another. The body is oblong, tapering most towards the tail, below plain, above convex, with a double, or flat margin: laterally on the back part of the thorax are two small tubercles, which may be the eyes: the body behind the thorax is crossed with twelve rings: legs six; feelers (antennæ) half the length of the body, jointed, hairy, each ending in two hairs as long as the antennæ: rump, a white point between two terminal hairs, which are as long as the body of the animal. The mouth I could not see. On opening the cells, the substance that they were formed of cannot be better described, with respect to appearance, than by saying it is like the transparent amber that beads are made of: the external covering of the cells may be about half a line thick, is remarkably strong, and able to resist injuries:

* This discovery of Mr. Roxburgh will bring Lac a genus into the class Hemiptera of Linnæus.

the partitions are much thinner : the cells are in general irregular ſquares, pentagons and hexagons, about an eighth of an inch in diameter, and one quarter deep : they have no communication with each other. All thoſe I opened during the time the animals were iſſuing, contained in one half, a ſmall bag filled with a thick red jelly-like liquor, replete with what I take to be eggs : theſe bags, or utriculi, adhere to the bottom of the cells, and have each two necks, which paſs through perforations in the external coat of the cells, forming the fore-mentioned excreſcences, and ending in ſome very fine hairs. The other half of the cells have a diſtinct opening, and contain a white ſubſtance, like ſome few filaments of cotton rolled together, and numbers of the inſects themſelves ready to make their exit. Several of the ſame inſects I obſerved to have drawn up their legs, and to lie flat : they did not move on being touched, nor did they ſhow any ſigns of life with the greateſt irritation.

December 5. The ſame minute hexapedes continue iſſuing from their cells in numbers : they are more lively, of a deepened red colour, and fewer of the motionleſs ſort. To-day I ſaw the mouth : it is a flattened point about the middle of the breaſt, which the little animal projects on being compressed.

December 6. The male inſects I have found to-day : a few of them are conſtantly running among the females moſt actively : as yet they are ſcarce more, I imagine, than one to 5000 females, but twice their ſize. The head is obtuſe ; eyes black, very large ; antennæ clavated, feathered, about $\frac{2}{3}$ the length of the body : below the middle an articulation, ſuch as thoſe in the legs : colour between the eyes a beautiful ſhining green : neck very ſhort : body oval, brown : abdomen oblong, the length of body and head : legs ſix : wings membranaceous, four, longer than the body, fixed to the ſides of the thorax, narrow at their inſertions, growing broader for $\frac{2}{3}$ of their length, then rounded ; the anterior pair is twice the ſize of the poſterior : a ſtrong fibre runs
along

along their anterior margins : they lie flat, like the wings of a common fly when it walks or rests : no hairs from the rump : it springs most actively to a considerable distance, on being touched : mouth in the under part of the head : maxillæ transverse. To-day the female insects continue issuing in great numbers, and move about as on the 4th.

December 7. The small red insects still more numerous, and move about as before : winged insects, still very few, continue active. There have been fresh leaves and bits of the branches of both *Mimosa Cinerea* and *Corinda* put into the wide mouthed bottle with them : they walk over them indifferently, without showing any preference, or inclination to work or copulate. I opened a cell whence I thought the winged flies had come, and found several, eight or ten, more in it, struggling to shake off their incumbrances : they were in one of those utriculi mentioned on the 4th, which ends in two mouths, shut up with fine white hairs, but one of them was open for the exit of the flies ; the other would no doubt have opened in due time : this utriculus I found now perfectly dry, and divided into cells by exceeding thin partitions. I imagine, before any of the flies made their escape, it might have contained about twenty. In these minute cells with the living flies, or whence they had made their escape, were small dry dark-coloured compressed grains, which may be the dried excrements of the flies*.

* The Hindoos have six names for Lac ; but they generally call it Lácshà from the multitude of small insects, who, as they believe, discharge it from their stomachs, and at length destroy the tree on which they form their colonies : a fine Pippala near Crishnanagar is now almost wholly destroyed by them.—NOTE BY THE PRESIDENT.

V. *Mayow anticipated: or, The Discoveries of HOOKE relative to the Composition of our Atmosphere. Communicated by Dr. THORNTON, Physician to the General Dispensary.*

HOOKE's Micrographia was, by the Council of the Royal Society, ordered to be printed, November 23, 1664.—Speaking of charcoal, Hooke observes, that “the body to be charred or coaled may be put into a crucible, pot, or any other vessel that will endure to be made red-hot in the fire without breaking, and then covered over with sand, so as no part of it be suffered to be open to the air; then set into a good fire, and there kept till the sand has continued red hot for a quarter, half, an hour or two, or more, according to the nature and bigness of the body to be coaled or charred; then taking it out of the fire, and letting it stand till it be quite cold, the body may be taken out of the sand well charred and cleansed of its waterish parts; but in the taking of it out, care must be had that the sand be very near cold, for else, when it comes into the free air, it will take fire, and readily burn away.

“This may be done also in any close vessel of glass, as a retort, or the like; and the several fluid substances that come over may be received in a fit recipient, which will yet further countenance this hypothesis: and their manner of charring wood in great quantity comes much to the same thing, namely, an application of a great heat to the body, and preserving it from the free access of the devouring air. This may be easily learned from the History of Charring of Coal, most excellently described and published by that most accomplished gentleman, Mr. John Evelyn, in the 100, 101, 103 pages of his Sylva; to which I shall therefore refer the curious reader that desires a full information of it.

“Next, we may learn what part of the wood it is that is the combustible matter; for, since we shall find that none, or
very

very little of those fluid substances that are driven over into the receiver are combustible, and that most of that which is left behind is so, it follows, that the solid interstitia of the wood are the combustible matter. Further, the reason why uncharred wood burns with a greater flame than that which is charred, is as evident, because those waterish or volatile parts issuing out of the fired wood, every way, not only shatter and open the body, the better for the fire to enter, but, issuing out in vapours or wind, they become like so many little æolipiles, or bellows, whereby they blow and agitate the fired part, and conduce to the more speedy and violent consumption or dissolution of the body.

“ Thirdly, from the experiment of charring of coals (whereby we see that notwithstanding the great heat, and the duration of it, the solid parts of the wood remain, whilst they are preserved from the free access of the air undissipated) we may learn, that which has not, that I know of, been published or hinted, nay, not so much as thought of, by any; and that in short is this.

“ First, that the air in which we live, move, and breathe, and which encompasses very many, and cherishes most bodies it encompasses, that this air is the menstruum, or universal dissolvent of all sulphureous * bodies.

“ Secondly, that this action it performs not till the body be first sufficiently heated, as we find requisite also to the dissolution of many other bodies by several other menstrooms.

“ Thirdly, that this action of dissolution produces or generates a very great heat, and that which we call fire; and this is common also to many dissolutions of other bodies made by menstrooms, of which I could give multitudes of instances.

“ Fourthly, that this action is performed with so great a violence, and does so minutely act and rapidly agitate the smallest parts of the combustible matter, that it produces in

* A term which, at the time in which the author wrote, meant *any inflammable body*.

the diaphanous medium of the air, the action or pulse of light, which, what it is, I have elsewhere already shewn.

“ Fifthly, that the dissolution of sulphureous bodies is made by a substance inherent, and mixt with the air, that is like, if not the very same with that which is fixt in saltpeter, which by multitudes of experiments that may be made with saltpeter, will, I think, most evidently be demonstrated.

“ Sixthly, that in this dissolution of bodies by the air, a certain part is united and mixt, or dissolved and turned into the air, and made to fly up and down with it in the same manner as a metalline, or other body dissolved into any menstruums, does follow the motions and progresses of that menstruum till it be precipitated.

“ Seventhly, that as there is one part that is dissoluble by the air, so are there other parts with which the parts of the air mixing and uniting do make a coagulum, or precipitation, as one may call it, which causes it to be separated from the air; but this precipitate is so light, and in so small and rarified or porous clusters, that it is very volatile, and is easily carryed up by the motion of the air, though afterwards, when the heat and agitation that kept it rarified ceases, it easily condenses, and commixt with other indissoluble parts, it sticks and adheres to the next bodies it meets withall; and this is a certain salt that may be extracted out of foot.

“ Eighthly, that many indissoluble parts being very apt and prompt to be rarified, and so, whilst they continue in that heat and agitation, are lighter than the ambient air, are thereby thrust and carryed upwards with great violence, and by that means carry along with them, not only that saline concrete I mentioned before, but many terrestrial, or indissoluble and irrarifiable parts, nay, many parts also which are dissoluble, but are not suffered to stay long enough in a sufficient heat to make them prompt and apt for that action. And therefore we find in foot, not only a part that, being continued longer in a competent heat, will be dissolved by
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the air, or take fire and burn; but a part also which is fixt, terrestrial and irrarifiable.

“Ninthly, that as there are these several parts that will rarifie and fly, or be driven up by the heat, so are there many others, that as they are indissoluble by the aërial menstruum, so are they of such sluggish and gross parts, that they are not easily rarified by heat, and therefore cannot be raised by it; the volatility or fixtness of a body seeming to consist only in this, that the one is of a texture, or has component parts that will be easily rarified into the form of air; and the other, that it has such as will not, without much ado, be brought to such a constitution; and this is that part which remains behind in a white body called ashes, which contains a substance, or salt, which chymists call alkali: what the particular natures of each of these bodies are, I shall not here examine, intending it in another place; but shall rather add, that this hypothesis does so exactly agree with all phænomena of fire, and so genuinely explicate each particular circumstance that I have hitherto observed, that it is more than probable, that this cause which I have assigned is the true, adequate, real, and only cause of those phænomena; and therefore I shall proceed a little further, to shew the nature and use of the air.

“Tenthly, therefore the dissolving parts of the air are but few, that is, it seems of the nature of those saline menstruums or spirits that have very much flegme mixt with the spirits, and therefore a small parcel of it is quickly glutted, and will dissolve no more; and therefore, unless some fresh part of this menstruum be applied to the body to be dissolved, the action ceases, and the body leaves to be dissolved and to shine, which is the indication of it, though placed or kept in the greatest heat; whereas saltpeter is a menstruum, when melted and red-hot, that abounds more with those dissolvent particles, and therefore, as a small quantity of it will dissolve a great sulphureous body, so will the dissolution be very quick and violent.

“ Therefore, in the eleventh place, it is observable, that, as in other solutions, if a copious and quick supply of fresh menstruum, though but weak, be poured on or applied to the dissoluble body, it quickly consumes it: so this menstruum of the air, if by bellows, or any other such contrivance, it be copiously applied to the shining body, is found to dissolve it as soon and as violently as the more strong menstruum of melted nitre.

“ Therefore, twelfthly, it seems reasonable to think that there is no such thing as an element of fire that should attract or draw up the flame, or towards which the flame should endeavour to ascend out of a desire or appetite of uniting with that as its homogeneal primitive and generating element; but that that shining transient body which we call flame, is nothing else but a mixture of air and volatile sulphureous parts of dissoluble or combustible bodies, which are acting upon each other whilst they ascend, that is, flame seems to be a mixture of air and the combustible volatile parts of any body, which parts the encompassing air does dissolve or work upon, which action, as it does intend the heat of the aërial parts of the dissolvent, so does it thereby further rarify those parts that are acting, or that are very near them, whereby they growing much lighter than the heavie parts of that menstruum that are more remote, are thereby protruded and driven upward; and this may be easily observed also in dissolutions made by any other menstruum, especially such as either create heat or bubbles. Now, this action of the menstruum or air on the dissoluble parts, is made with such violence, or is such, that it imparts such a motion or pulse to the diaphanous parts of the air, as I have elsewhere shewn is requisite to produce light.

“ This hypothesis I have endeavoured to raise from an infinity of observations and experiments, the process of which would be much too long to be here inserted, and will perhaps another time afford matter copious enough for a much larger discourse, the air being a subject which (though all the

the world has hitherto lived and breathed in, and been unconversant about) has yet been so little truly examined or explained, that a diligent enquirer will be able to find but very little information from what has been (till of late) written of it: but being once well understood, it will, I doubt not, enable a man to render an intelligible, nay probable, if not the true reason of all the phænomena of fire, which, as it has been found by writers and philosophers of all ages a matter of no small difficulty, as may be sufficiently understood by their strange hypotheses and unintelligible solutions of some few phænomena of it; so will it prove a matter of no small concern and use in human affairs, as I shall elsewhere endeavour to manifest when I come to shew the use of the air in respiration, and for the preservation of the life, nay, for the conservation and restauration of the health and natural constitution of mankind as well as all other aërial animals, as also the uses of this principle or propriety of the air in chymical, mechanical, and other operations. In this place I have only time to hint an hypothesis, which, if God permit me life and opportunity, I may elsewhere prosecute, improve and publish."

This appears to be exactly the doctrine of Mayow, who first published his treatise on respiration in 1668, and his other treatises on the composition of nitre, &c. in 1674, shewing clearly the priority of Hooke.

VI. *On a New Kind of Sympathetic Ink.* By M. MEYER.
From Crell's Chemical Annals, Vol. I. 1798.

A TRAVELLER, who wished to have sympathetic ink of a rose red colour, shewed me a receipt he had procured for preparing an ink of that kind; according to which, cobalt was to be dissolved in the nitrous acid, and a quantity of saltpetre, equal to that of the cobalt dissolved, was to be added to the solution; but as this process had never suc-

ceeded with him, I resolved to make some experiments to ascertain the point. My first object was to procure pure cobalt; but as I was unwilling to sacrifice pure pieces of any considerable size, I made choice of one which was visibly mixed with bismuth, iron and quartz. I endeavoured to separate the bismuth as much as possible, and also the arsenic if it should contain any, by bringing it slowly to a red heat; and I succeeded pretty well, as the bismuth flowed from it in abundance; and the arsenic, the quantity of which was small, was volatilised: many globules of bismuth still adhered to it. By bringing it repeatedly to a red heat, and then quenching it in water, it was reduced to such a state as to be easily pulverised. Having poured nitrous acid upon the powder, I obtained by digestion a beautiful rose red solution; the siliceous earth was separated in the form of a white slime, and by diluting it with water there was deposited a white powder, which was oxyd of bismuth. The solution being filtered, I added to it a solution of potash, and obtained a precipitate inclining more to a yellow than to a red colour. I again poured over it a little of the nitrous acid, by which a part of the oxyd was re-dissolved of a red colour: the remaining part, which had a dark brown colour, was oxyd of iron. From the solution, by the addition of potash, a precipitate was formed, which was now reddish. Having by this process obtained it pure; that I might now prepare from it the wished for red ink, I dissolved the washed pure oxyd of cobalt in different acids. That dissolved in the nitrous acid with a mixture of nitre, gave a green ink like the common: that dissolved in the sulphurous acid, without the addition of salts, gave a reddish ink, which remained after it was exposed to heat, and would not again disappear, even when a solution of nitre was applied; and that dissolved in the muriatic acid gave a green ink, darker and more beautiful than the common. By dissolving it, however, in the acetous acid, and adding a little nitre, I obtained what I had in view; for it gave, on the application of heat,

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an ink of a red colour, like that of the *rosa centifolia*, which again disappeared when the paper became cold. I was not able to obtain it of a darker tint; but I must confess that I made only a few experiments for that purpose, as I was satisfied with the colour I had got.

VII. *Description of M. DE SAUSSURE'S Diaphanometer.*

By Dr. F. W. AUG. MURHARD, of Gottingen. From Neues Journal der Physik, by Professor GREN. Vol. IV.

THIS instrument, first described by M. de Saussure in the fourth volume of the Memoirs of the Royal Academy of Sciences at Turin, has some resemblance to the *cyanometer**, both in regard to its object and construction. The principal difference is, that the latter shews the whole effect of the vapour and evaporation diffused throughout the atmosphere, from the eye of the observer to the utmost boundary of his view; while the diaphanometer is, on the other hand, designed to shew the greatness of the evaporations existing in any limited part of the atmosphere which surrounds us.

The measure of transparency in M. de Saussure's instrument, is founded on the proportion of the distances at which determined objects cease to be visible; and the point was to find objects, the disappearance of which, at a certain distance, could be determined with the greatest accuracy. M. de Saussure found that the moment of disappearance can be observed much more accurately when a black object is placed on a white ground, than when a white object is placed on a black ground; that the accuracy was still greater when the observation was made in the sun, than in the shade; and that even a still greater degree of accuracy was obtained, when the white space surrounding a black circle, was itself surrounded by a circle or ground of a dark colour. This last

* An instrument for determining the degree of the blueness of the heavens.

circumstance was particularly remarkable, and an observation quite new.

If a circle totally black, of about two lines in diameter, be fastened on the middle of a large sheet of paper or pasteboard, and if this paper or pasteboard be placed in such a manner as to be exposed fully to the light or the sun, if you then approach it at the distance of three or four feet, and afterwards gradually recede from it, keeping your eye constantly directed towards the black circle, it will appear always to decrease in size the farther you retire from it, and at the distance of 33 or 34 feet will have the appearance of a point. If you continue still to recede, you will see it again enlarge itself; and it will seem to form a kind of cloud, the darkness of which decreases more and more according as the circumference becomes enlarged. The cloud will appear still to increase in size, the farther you remove from it; but at length it will totally disappear. The moment of the disappearance, however, cannot be accurately ascertained; and the more experiments were repeated, the more were the results different. This is an observation perfectly accurate; and having myself made a series of experiments under like circumstances, I am the more convinced of the truth of it.

M. de Sauffure, having reflected for a long time on the means of remedying this inconveniency, saw clearly, that, as long as this cloud took place, no accuracy could be obtained; and he discovered that it appeared in consequence of the contrast formed by the white parts which were at the greatest distance from the black circle. He thence concluded, that if the ground was left white near this circle, and the parts of the pasteboard at the greatest distance from it were covered with a dark colour, the cloud would no longer be visible, or at least almost totally disappear.

This conjecture was confirmed by experiment. M. de Sauffure left a white space around the black circle equal in breadth to its diameter, by placing a circle of black paper a line in diameter on the middle of a white circle three lines

in diameter, so that the black circle was only surrounded by a white ring a line in breadth. The whole was pasted upon a green ground. A green colour was chosen, because it was dark enough to make the cloud disappear, and the easiest to be procured.

The black circle, surrounded in this manner with white on a green ground, disappeared at a much less distance, than when it was on a white ground of a large size.

If a perfectly black circle, a line in diameter, be pasted on the middle of a white ground exposed to the open light, I can observe it at the distance of from 44 to 45 feet; but if this circle be surrounded by a white ring a line in breadth, while the rest of the ground is green, I lose sight of it at the distance of only $15\frac{1}{2}$ feet.

According to these principles M. de Saussure delineated several black circles, the diameters of which increased in a geometrical progression, the exponent of which was $\frac{3}{2}$. His smallest circle was $\frac{1}{5}$ or 0.2 of a line in diameter; the second, 0.3; the third, 0.45; and so on to the sixteenth, which was 87.527, or about 7 inches $3\frac{1}{2}$ lines. Each of these circles was surrounded by a white ring, the breadth of which was equal to the diameter of the circle, and the whole was pasted on a green ground.

M. de Saussure, for his experiments, selected a straight road or plain of about 12 or 1500 feet in circumference, which towards the North was bounded by trees or an ascent. Those who repeat them, however, must pay attention to the following remarks:—When a person retires backwards, keeping his eye constantly fixed on the pasteboard, the eye becomes fatigued, and soon ceases to perceive the circle; as soon therefore as it ceases to be distinguishable, you must suffer your eyes to rest; not, however, by shutting them, for they would when again opened be dazzled by the light, but by turning them gradually to some less illuminated object in the horizon. When you have done this for about half a minute,
and

and again directed your eyes to the pasteboard, the circle will be again visible, and you must continue to recede till it disappears once more. You must then let your eyes rest a second time in order to look at the circle again, and continue in this manner till the circle becomes actually invisible.

If you wish to find an accurate expression for the want of transparency, you must employ a number of circles, the diameters of which increase according to a certain progression, and a comparison of the distances at which they disappear will give the law according to which the transparency of the atmosphere decreases at different distances. If you wish to compare the transparency of the atmosphere on two days, or in two different places, two circles will be sufficient for the experiment.

According to these principles, M. de Sauffure caused to be prepared a piece of white linen cloth eight feet square. In the middle of this square he sewed a perfect circle, two feet in diameter, of beautiful black wool; around this circle he left a white ring two feet in breadth, and the rest of the square was covered with pale green. In the like manner, and of the same materials, he prepared another square; which was, however, equal to only $\frac{1}{12}$ of the size of the former, so that each side of it was 8 inches; the black circle in the middle was two inches in diameter, and the white space around the circle was 2 inches also.

If two squares of this kind be suspended vertically and parallel to each other, so that they may be both illuminated in an equal degree by the sun; and if the atmosphere, at the moment when the experiment is made, be perfectly transparent, the circle of the large square, which is twelve times the size of the other, must be seen at twelve times the distance. In M. de Sauffure's experiments the small circle disappeared at the distance of 314 feet, and the large one at the distance of 3588 feet, whereas it should have disappeared at the distance of 3768. The atmosphere, therefore, was not perfectly transparent.

transparent. This arose from the thin vapours which at that time were floating in it.

It is of great importance to ascertain the laws according to which the distinctness of the visibility of an object decreases, either when the transparency of the medium through which the object is viewed is lessened, or when the thickness of the stratum of the medium is increased. Lambert, in his *Photometry*, has given an account of many ingenious experiments which he made on the decrease of the quantity of light, by its propagation through a medium imperfectly transparent; but M. de Saussure is the first who has considered the decrease of the distinctness with which an object is seen through such a medium at different distances.

VIII. *History of Astronomy for the Year 1798. Read in the College de France, Nov. 20. By JEROME LALANDE, Inspector and Dean of the College, and formerly Director of the Observatory.*

BEING permitted for the tenth time to entertain the public with the progress of a science which has engaged my attention fifty years, I am happy in being able to announce things still more interesting than on the last occasion; and, in the first place, the conclusion of that grand operation the measurement of the earth, or of $9\frac{2}{3}$ degrees of the meridian from Dunkirk to Barcelona.

About the middle of January, Delambre, impatient to begin his fatiguing labours, proceeded, notwithstanding the cold and the rain, to prepare a base from Lieurfaint to Melun; to complete the wooden pyramids, which were seventy feet in height, and to measure the angles.

On the 24th of February he had already finished seven stations for the angles at the base: three men had been employed for six weeks to cut down and remove from the highway

way six or seven hundred trees which interrupted the view of the signals.

On the 17th of April he set out to measure the base from Melun to Lieurfaint; a laborious operation, to which so much attention was paid that, though assisted by seven persons, they measured only 180 toises a day.

On the 3d of June the measurement of the base of three leagues, 6075 toises, was finished at Lieurfaint.

On the 30th of June C. Delambre set out to measure the base of Perpignan, which was terminated by the middle of September. At the same time C. Mechain finished his triangles between Rodez and Carcassone, after being exposed to illness, impediments, and delays of every kind. Being more unfortunate, and less robust than his colleague, his zeal served only to torment him the more.

On the 17th of November they at length arrived at Paris, after finishing their calculations, from which it appeared that the two bases perfectly agreed. Thus this immense enterprise of a new measurement of the earth, begun in the month of June 1792, by our two ablest astronomers, is at length terminated; and we shall soon have the results so much wanted, for the size and figure of the earth, and perhaps for its irregularities. These two astronomers mean also to determine again the latitude of Paris, which I had fixed at $48^{\circ} 50' 15''$ three years ago, from two hundred observations, made with an astronomical circle, for which we are indebted to C. Borda, by diminishing the refraction of Bradley one second, and this is all the uncertainty that remains.

The grand labour of determining the position of the stars, begun in 1789, has been carried to 47,000; and there remains only 2000 to complete the tour of the heavens as far as the lower tropic. By taking two degrees beyond it, there will be 50,000. C. Lefrançois proposes to finish this labour next winter. Comets are at present the only part of astronomy in which little progress has been made; but it is now
about

about to engage the attention of our astronomers. I was desirous of preparing for them the only assistance which was wanting, by giving them the positions of the stars in every part of the heavens. They will never be able to observe comets without being obliged to have recourse to our 50,000 stars, and without being certain of finding there every thing they could wish: I know this by the experience of several years.

But detractors will never be wanting to every great and important work; they will say it would be much better to have fewer stars, and to have their positions ascertained with more accuracy. They are however mistaken; it is the great number of stars that supplies the data requisite for this labour: a greater precision is useless at present, and will be so for a long time. Comets are never observed nearer than 30 seconds, and yet they wish to have the positions of the stars to one second; this is an evident absurdity, and a manifest impossibility. We have then done every thing that was necessary and possible to be done; and I consider myself happy in having terminated my career, by procuring for astronomy a monument which, on account of its magnitude, might have been thought impossible. To shew the utility of C. Lefrançois' labour, it will be sufficient to say, that in a zone of three hours, having two degrees of breadth, there were thirty new stars of the fifth and sixth, and between the sixth and the seventh magnitudes, yet no more than three of them were known. On the 10th of December 1789, of one hundred stars, thirteen of which were of the sixth magnitude, there was only one known: the other twelve are new to us. This is enough to prove how far we were from being acquainted with the starry heavens, and from knowing how many stars were visible to the naked eye. For that reason I was induced to employ myself in this labour as soon as I was able to procure a good instrument. M. Herschel has also undertaken a review of the heavens with his twenty-feet telescope, but only for the purpose of finding *nebulae*, or objects difficult to be seen.

Our labour is more important, since it gives the exact position of all the stars which astronomers may have occasion to use. Herschel observes only things invisible, and astronomers have need of sensible objects that are always present to their view.

We may therefore say of C. Lefrançois, what Virgil said of Palinurus: *Sydera cuncta notat tacito labentia cœlo*; for he has really done what Palinurus never did.. C. Lefrançois has already reduced 6000, and he promises 4000 for the present year, though each requires thirty-six operations. In the month of September I caused to be erected in the Military School a new meridian telescope by Lenoir, with a large object-glass by Caroché: it is better placed than the former; the supports have no connection with the roof, and the instrument is less subject to vary by the changes of temperament. With this instrument we shall continue to determine the right ascension of the principal stars of all our zones of fifty thousand.

The theory of physical astronomy has also had a remarkable epoch this year. C. Laplace, to whom we are indebted for an explanation of the acceleration of the moon, has found that the apogee and node have likewise secular equations; and this noble discovery has been confirmed by a great number of observations. It would be useful to confirm it still farther, by the observations of the middle ages, of which there are a few. The manuscript of Ibn-Iunis, an Arabian of the tenth century, contains valuable observations: the original is at Leyden, and we have made fruitless efforts to obtain a copy of it. C. Caussin, one of our professors of Arabic, offered to go to Leyden and copy the observations; but I have found a copy among the manuscripts of J. Delisle, my predecessor in the *College de France*, and I hope we shall soon have the results of these valuable observations.

On the 19th of March, the Institute proposed, as the subject of a prize, a comparison of 500 observations of the moon, with the tables to determine better the 22 equations which we employ at present for the moon's motion; and I already

know.

know a competitor who has made immense calculations on that subject. Our prize will serve to terminate and render public that important labour which, united to Laplace's theory, will bring the moon's tables, and the calculation of the longitude, to a new degree of precision. If errors of three myrametres (seven leagues) were formerly committed at sea through the fault of the tables, they will soon be reduced to two or three.

C. Messier, who continues to search for comets, discovered one on the 12th of April 1798, towards the Pleiades; it was small, and without any tail, but of considerable brilliancy: it could not be distinguished by the naked eye. It forms the twenty-first which C. Messier has discovered since 1758, and the forty-first he has observed. The number of the comets now known is 88, according to the catalogue in my astronomy. Dr. Burckhardt, an able astronomer of Gotha, who had been some months at Paris, lost no time to calculate the orbit of this comet, which he did in two days, a circumstance very extraordinary. I have published C. Messier's observations, which Dr. Burckhardt reduced and calculated by employing several positions of the new stars furnished by C. Lefrançois, my nephew. This comet was almost as remote from us as the sun, and its distance varied little for a month. It ceased to be visible after the 24th of May. I had traced out its course on pasteboard for my auditors, as I generally do, and any one could there see its distance and situation for each day. C. Bouvard, at the observatory, made also various observations, which we shall publish with those of C. Messier, until they appear more at large in the Memoirs of the National Institute, with a chart of its course, as C. Messier always gave in the Memoirs of the ci-devant Academy. Dr. Olbers at Bremen observed it also as soon as he was informed of it by the *Journal de Paris*.

But before this real comet, Paris resounded with the report of a pretended comet. On the 16th of January a new

comet was announced on the Pont-Neuf, and many people were frightened. It however turned out to be only Venus, which was seen during the open day over the Luxembourg, at a time when 20,000 persons assembled to see General Bonaparte had their eyes directed towards that quarter. With proper attention, Venus might be seen in the like manner every 19 months; but few people have time or opportunity to make such observations. On this occasion the terror was singular. A piece called the *Comet*, or the *End of the World*, was represented at the Vaudeville. Ruggieri exhibited an artificial comet at the Lyceum: it had a great resemblance to the beautiful comet of 1744, which I recollect to have seen, and which was the most astonishing of that century.

On the 6th of December 1798, in the evening, C. Bouvard discovered a small comet in the constellation of Hercules. This makes the 89th. It was observed till the 11th, when it disappeared in Aquarius. It moved at the rate of eighteen degrees per day. Though it appeared only five days, we have, therefore, sufficient data to calculate its orbit. It was seen at Bremen by Dr. Olbers.

On the 21st of November a comic opera, called the *Astronomer*, was represented at the theatre in the *Rue Feydeau*. It is founded on a circumstance similar to that of the *Total Eclipse*; the first idea of which seems to have been borrowed from *Les Memoires Turcs*. It exhibits an old simpleton deceived while he pretends to observe a comet.

On the 18th of January, C. Dangos, at Tarbes, saw a comet pass over the sun like a black spot. This new and singular observation may be useful when we become acquainted with a great number of comets; but we are totally ignorant of the course of the one which was seen that day on the sun's disk.

An important and celebrated voyage has given new hopes to astronomy and geography. On the 16th of March government expressed a desire of having select astronomers and instruments for a secret expedition. We soon learned that

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the famous General Bonaparte, was to be at the head of it. I could recommend only citizens Nouet, Quenot, and Mechain the son. They gladly embarked in this noble enterprise, and set out on the 24th of April. On the 10th of May they sailed from Toulon, landed in Egypt on the 2d of July; and I have no doubt that this voyage will be useful to geography, and even astronomy. I have written to all the astronomers of Europe to request them to co-operate, by corresponding observations, with those which will be made by the astronomers of that expedition.

Young Bernier, of Montauban, was desirous of sharing in the voyage, but we applied for him too late. I recommended to the attention of our astronomers, the level of the Mediterranean and the Red Sea, in which it has been often said there is a great difference, but I do not believe it. I have written to Spain to procure information in regard to that of the South Sea and the Gulph of Mexico, at the Isthmus of Panama, respecting which the like difficulties have been started.

The observatory of Gotha is the most beautiful and most useful in Germany. The duke has expended on it more than 200,000 livres. No prince or king in the present century has followed his example. M. von Zach, the director of the observatory, is one of the most celebrated astronomers in Europe. I had long wished to visit and be acquainted with the only monument of astronomy which I had not seen, after the example of Halley, who went from England to Denmark in 1679, to see the observatory of Hevelius, to converse with him, and examine the accuracy of his observations. I have found that M. von Zach can observe the polar star to a second, instead of a hundred seconds, which we had of uncertainty. Several German astronomers, being informed of this design, assembled there also. Our conferences served to increase our emulation. I brought back 1200 ascensions of zodiacal stars, each observed several times by M. von Zach, with the most beautiful transit instrument in existence. They

will appear, together with 3000 declinations which I have sent to M. von Zach, in an important work he is about to publish on astronomy, in two volumes octavo, and of which two thirds are already printed:

M. Bode brought from Berlin drawings of his thirteenth chart of the starry heavens. There will be twenty in the whole; and this collection, of the utmost value to astronomers, will contain 13,000 stars, or 8000 more than ever were represented before. He has reduced 3000 of Lacaille's stars, and has observed 1500 himself to fill up vacancies; C. Lefrançois supplied him with the rest. There will be found in it the 2000 nebulae of Herschel, and from five to six hundred double stars of that celebrated astronomer. We have formed two new constellations, the Prefs of Guttemberg, and Mongolfier's Balloon.

M. Wurm came to meet us from Wirtemberg, the distance of a hundred leagues. The duke of Wirtemberg gave him a gratuity of 800 livres. He assured me that he would still collate the new stereotype tables of C. Firmin Didot, in order that this undertaking, which must ensure correctness to our calculations for more than a century, may be rendered as perfect and useful as possible.

Messrs. Klugel, Gilbert and Pistor, came from Halle, a celebrated university in the king of Prussia's dominions, and M. Schaubach from Meinungen. M. Seyffer, of Göttingen, promised us some observations and calculations, of which we are in want. M. Köhler brought with him a new photometer to measure the light of the stars, and a reflecting heliostat, which is a very ingenious machine. M. Feer, of Zurich, brought a chart of the Rinthal, constructed from observations with a sextant. All these philosophers agreed to recommend the new system of measures, and to employ the mean time and decimal reckoning in their calculations. M. Seyffert, of Dresden, gave me a stop watch, with the hour plate divided according to the decimal method which was executed by himself. We went to the top of the

mountain

mountain of Infelberg, with chronometers, sextants, and artificial horizons of different forms, in order to compare them; and I am fully convinced that the geography of Germany will soon be improved by the use of these instruments, which M. von Zach has recommended and made better known.

This useful congress would perhaps have been more numerous; but M. Vega wrote to me from Austria, that he was not able to obtain permission to meet us at Gotha; and, what is still worse, he was obliged to send my letter, and his own answer, to the minister for his inspection. The king of Prussia, on the other hand, made an addition of 1200 livres to the allowance of his astronomer on account of this journey. The astronomer of Gottingen, though a subject of the king of England, experienced no difficulty.

An English Journal had hinted to the duke of Gotha, that a French astronomer might perhaps be employed with other revolutions than those of the heavenly bodies; but I did not find that this suggestion diminished in the least the favourable reception I had been taught to expect. We at last separated, after being fully convinced of the utility of such conferences, and with a resolution of renewing them as often as we could *.

[To be concluded in next Number.]

IX. *Observations and Experiments in regard to the Figures formed by Sand, &c. on Vibrating Surfaces*, by J. G. VOIGT. From *Neues Journal der Physik*, by Professor GREN, Vol. III.

DR. CHLADNI of Wittemberg, by his experiments on vibrating surfaces, in the year 1787, opened a new field in mechanics, viz. the consideration of the curves formed by surfaces put in a state of movement. His discoveries, there-

* For Professor Bode's account of this meeting of astronomers, see 324 of the present volume.

fore, were so much the more valuable ; but, as far as I know, few besides himself have employed their attention on this subject, and perhaps because it requires long practice to perform experiments of this nature, so as to make progress in a branch of science hitherto uncultivated. But, until these experiments shall more engage the attention of philosophers, we cannot expect that the subject will be much illustrated; and therefore I conceive it may be of some utility if I here give a short account of the method of making experiments on vibrating surfaces, which I hope will enable any one to repeat them with facility.

I have for some time past turned my attention to such experiments, and I flatter myself that I have made improvements in regard to those which Dr. Chladni announced in his *New Theory of Sound*. By my experiments I was conducted to many rules, a knowledge of which will render it very easy to repeat these experiments. I made them according to the instructions given by Dr. Chladni in the work above mentioned, which appears to me, however, to be rather too short.

The vibration figures arise, it is well known, because during the movement of a surface, which is connected with the sensation of sound in our organs of hearing, some parts of the surface are at rest, and others in motion. If the surface be strewed over with bodies easily put in motion, such for example as sand, these during the vibration remain on the parts at rest, and are thrown from the parts in motion. The form of the parts at rest, which will be shewn by the sand that remains unmoved, and which in general is symmetric, is called a vibration figure. To produce such a figure, nothing is necessary but to know the method of bringing that part of the surface which you wish not to vibrate into a state of rest, and of putting in motion that which you wish to vibrate : on this depends the whole expertness of producing vibration figures.

The surfaces fittest for being made to vibrate, are panes
of

of glass, though the experiments will succeed equally well with plates of metal, or pieces of board, of a line or two in thickness. One might now believe that to produce fig. 2. (*See Plate VIII.*) it would be necessary to damp, in particular, every point of the part to be kept at rest, viz. the two concentric circles and the diameter, and to put in motion every part intended to be made to vibrate. This, however, is not the case; for you need damp only the points *a* and *b*, and cause to vibrate one part *c* at the edge of the plate, for the movement is soon communicated to the other parts which you wish to vibrate, and the required figure will in this manner be produced. How and why the movement takes place in this manner, and in no other, is difficult to be explained, and would lead me too far, as I wish merely to give a few rules for making the experiments.

The damping may be best effected by laying hold of the place to be damped between two figures, or by supporting it only by one finger. This will be comprehended more clearly by turning to fig. 6. where the hand is represented in that position necessary to hold the plate. In order to produce fig. 3. you must hold the plate horizontally, placing the thumb above at *a*, with the second finger directly below it; and, besides this, you must support the point *b* on the under side of the plate. If you then rub the bow of a violin against the plate at *c*, you will produce on the glass the figure which is delineated fig. 3. When the point to be supported or damped lies too near the centre of the plate, you may rest it on a cork, not too broad at the end, in contact with the glass, in order to supply the place of the finger. It is convenient also, when you wish to damp several points at the circumference of the glass, to place your thumb on the cork, and use the rest of your fingers for touching the parts which you wish to keep at rest. For example, if you wish to produce fig. 4. on an elliptic plate, the larger axis of which is to the lesser as 4 to 3, you must place the cork under the centre *c* of the plate; put your thumb upon this point, and then damp the two

C c 4

points

points of the edge p and q , as may be seen fig. 5. and make the plate to vibrate by rubbing the violin bow against it at r . There is still another convenient method of damping several points at the edge when you employ large plates. Fig. 1. represents a strong square bit of metal $a b$, a line in circumference, which is screwed to the edge of a table, or made fast in any other manner; and a notch about as broad as the edge of the plate is cut into one side of it with a file. You then hold the plate, resting against this bit of metal by two or more fingers when requisite, as at c and d ; by which means the edge of the plate will be damped in three points d, c, e ; and in this manner, by putting the plate in vibration at f , you can produce fig. 10. In cases of necessity you may use the edge of a table instead of the bit of metal; but it does not answer the purpose so well.

To produce the vibration at any required place, a common violin bow rubbed with resin is the most proper instrument to be employed. The hair must not be too slack, because it is sometimes necessary to press pretty hard on the plate, in order to produce the tone sooner.

When you wish to produce any particular figure, you must first form it in idea upon the plate, in order that you may be able to determine where a line at rest and where a vibrating part will occur. The greatest rest will always be where two or more lines at rest intersect each other; and such places must, in particular, be damped. For example, in fig. 7. you must damp the part n , and stroke with the bow in p . Fig. 11. may be produced with no less ease, if you hold the plate at r , and stroke with the bow at f . The strongest vibration seems always to be in that part of the edge which is bounded by a curve: for example, in fig. 8. and fig. 9. at n . To produce these figures, therefore, you must rub with the bow at n , and not at r .

You must, however, damp not only those points where two lines intersect each other, but endeavour to support at least one which is suited to that figure and to no other.

For

For example, when you support *a* and *b* (*fig. 2.*), and rub with the bow in *c*, *fig. 7.* also may be produced, because these figures have both these points at rest. To produce *fig. 2.* you support with one finger the part *e*, and rub with the bow in *c*; and in this manner *fig. 7.* cannot be produced, because it has not the point *e* at rest. One of the greatest difficulties in producing the figures is to determine before hand the vibrating and resting points which belong to a certain figure and to no other.

Hence it happens that when one is not able to support those points which distinguish one figure from another, if the violin bow be rubbed against the plate, several hollow tones are heard without the hand forming itself as expected. One must therefore acquire by experience a readiness in being able to search out, among these tones, that which belongs to the required figure, and to produce it on the plate by rubbing the bow against it. But it requires great practice to determine the figure previously from the tone, or to search out, among various tones, that which belongs to the figure, and to know how to make the plate vibrate in such a manner that this tone alone, and not another, shall be heard. For this purpose you must first listen, and then alter the mode of rubbing; and as soon as the right tone is produced, you must rub somewhat harder with the violin bow, by pressing it more strongly against the edge of the plate. The latter must be done in particular in regard to high tones. As soon as you have acquired sufficient expertness in this respect, you can, as I myself have experienced, determine before hand, with a considerable degree of certainty, the figures to be produced, and even the most difficult. This practice will be attended with the greatest advantage, if, when you rub the bow against the plate for the first time in order to produce a figure, you continue the rubbing that the tone may be imprinted in the memory, and if you try, after some time, to produce the same tone again. It may be readily conceived that you must not forget what parts of the plate, and in what manner you damped;

damped; and you may mark these points by making a scratch on the plate with a bit of flint.

When the plate has acquired the proper vibration, you must endeavour to keep it in that state for some seconds, which can be best done by rubbing the bow several times in succession. By these means the sand will be formed much more accurately.

Any sort of glass may be employed for these experiments, provided its surface be smooth; otherwise the sand will fall into the hollow parts, or be thrown about in an irregular manner. The surface of the common green glass is, however, not very smooth, and often full of cavities. The figures, therefore, formed upon it are not so clear and accurate as those formed upon smooth white glass, which is the kind I employ.

When there are several places on the plate where there are stripes in the mass of the glass, they hurt the experiments, especially in producing those figures where a vibrating part falls upon several of these stripes. In that case the figures are not so symmetric as on other plates. I have in my possession, for example, a circular plate of glass 20 inches in diameter, on which I was never able to produce a perfect circle as on other plates, the circle always appearing like a very long ellipse. This plate contains a great many of the above-mentioned stripes. The flaws and knots which occur in glass are not very hurtful.

Common glass plates, when cut with a stone, are very sharp on the edge, and would soon destroy the hair of the violin bow: on this account the edge must be rendered somewhat smooth. For that purpose I employ a file or a piece of coarse hard free stone. It is of no great consequence, according to my observations, whether the edges be very smooth or roughly ground, provided they be in such a state as not to injure the hair of the bow.

You must endeavour to procure such plates as are pretty equal in thickness. It may be said, in general, that a plate
the

the thinner it is will be so much the fitter for these experiments, though in this respect there is a certain minimum. In small plates, such as those that are circular, and not above six inches in diameter, the observation is general; but in larger plates too great thinness is prejudicial. Besides, it will be found that very thin glass is commonly very uneven, and, as has been already said, must therefore be unfit for the experiments. If you have a plate, however, which is on one side thicker than on the other, you must endeavour to produce the figure on the plate in such a manner that you can rub the violin bow against the thinnest part.

In the last place, in practising the experiments, you must have glass plates of different sizes, such, for example, as circular ones of from four to twelve inches in diameter: for, on a small one of four inches in diameter, you cannot produce three concentric circles with two or more diameters; and on a larger, for example, of twelve inches of diameter, you cannot so easily produce a single circle as on a circular plate of three inches diameter. Sometimes it is difficult to make the figure appear on a plate, while on another it is very easy. Sometimes it appears only when you hold the plate in a certain place. These are phenomena which arise partly from the unlike thickness of the glass, and partly from the stripes and flaws in it.

You must not employ too fine sand, but rather that which is coarser; because the former is easier thrown from the vibrating parts, while the latter adheres better to them. It must be of such a nature that when you incline the glass-plate it may readily roll off; because, in that case, it will be easily thrown from the vibrating parts. It will be of advantage that it be mixed with fine dust, which shews peculiar phenomena during the experiments, as it collects itself at one place of the vibrating part.

The plate must be equally bestrewed with sand, and not too thick, as the lines will then be exceedingly fine, and the figures will acquire a better defined appearance.

Those

Those who wish to exercise themselves in these experiments may try to produce the figures spoken of by Dr. Chladni, in his before-mentioned work, following his directions, and the rules here given: but they must not be discouraged if the figures are not produced on the first trials; for, in general, to learn the method of making the experiments requires some time.

The above rules contain some general laws which vibrating surfaces follow; but as my object here was to give only a short view of the manner in which experiments must be made, I shall not enter into a further explanation of these laws, as I mean to treat the subject more fully on some other occasion.

X. *Communication from Mr. CRUICKSHANK, Chemist to the Ordnance, relative to a Mistake in the last Edition of Dr. SMYTH'S Treatise on the Effects of Nitrous Vapour in preventing and destroying Contagion. With an Account of the Methods now employed at Woolwich for fumigating with the Sulphurous Acid, and with Oxygenated Muriatic Acid Gas.*

TO THE EDITOR OF THE PHILOSOPHICAL MAGAZINE.

SIR,

IN the last edition of Dr. Smyth's Treatise on the effects of nitrous vapour in preventing and destroying contagion, I was not a little surpris'd to find, at page 221, the following passage, in a letter to Dr. Percival, dated August 1, 1796:

“ Whether this will apply to the small-pox, I cannot say
 “ from my own experience; but I have been told by Dr. Rollo
 “ surgeon to the artillery, and Mr. Cruickshank professor-royal
 “ of chemistry to the academy, that it destroys the miasma of
 “ small-pox; and that, of two quantities of matter taken for
 “ the purpose of inoculation, one was expos'd to the nitrous
 “ vapour, the other not: the persons inoculated with the
 “ first

“ first were not seized with the disease, whilst the inoculation
“ took the usual effect when performed with the second.”

In the conversation which Dr. Rollo and myself had with Dr. Smyth, about the different methods of destroying contagion, I gave it as my opinion, that the ox. muriatic acid, in the form of gas, deserved the preference, for the following reasons :—1st, From its being a permanently elastic fluid, it was much more diffusible than the vapour of nitrous acid—and, 2ndly, from the facility with which it destroyed the contagion of small-pox in the most concentrated state, I had little doubt of its efficacy in eradicating contagions in general. I then mentioned the experiments with small-pox matter, which are related in the first edition of Dr. Rollo's *Treatise on Diabetes* *. How the Doctor could confound this gas with the vapour of nitrous acid, with which at that time I had made no trials, it is difficult to conceive ; but however this may be, it is necessary the mistake should be corrected : for, although it be possible, and even probable, that nitrous vapour may destroy the contagion of small-pox, yet it should never be admitted as a fact until proper and satisfactory experiments have been made. In the same conversation I mentioned the method now employed at Woolwich for fumigating with the sulphurous acid, and which we supposed had some advantages over that usually practised. It consists in mixing intimately two or three parts of pulverised sulphur with one of nitre ; a certain quantity of this mixture, proportioned to the size of the apartment, is to be introduced into an iron pot,

* Mr. Cruickshank, in March 1795, took two portions of recent small-pox matter from the same person, and exposed one portion to this gas (the ox. mur. acid gas) for a few minutes, and with it inoculated the left arms of three drummers, while the right arms were inoculated with some of the other portion. The punctures of the left arms had no marks of inflammation, except what simple puncture produces, and they entirely disappeared in a few days. But the right arms took on the variolous action, and in two of the persons there was a general eruption. This experiment has been since repeated, and with the same success. *Rollo on the Diabetes Mellitus*, vol. i. p. 61.

and placed upon some bricks, or wet sand, in the middle of the floor. After the people have been removed, and the windows, &c. closely shut, the composition is to be set on fire by a live coal. During the combustion a great quantity of sulphurous acid gas, mixed with sulphuric acid in the state of vapour, is disengaged, and concentrated to such a degree as to force its way into the smallest apertures.

In the common method of burning sulphur it is impossible to concentrate the sulphurous acid in this manner, as the combustion ceases when the pure air in the room, &c. is nearly consumed; but in this case the oxygen is supplied by the nitre, and, the combustion being carried on with great rapidity, a prodigious quantity of gas, &c. is disengaged in a very short space of time.—It is true that this mode of fumigation cannot be put in practice while the patients are present: we doubt much, however, if the same objection is not applicable to any other, which shall be completely effectual in every case; for, to prevent the generation and spreading of contagion, is a very different thing from entirely eradicating it, after it has been produced, and attached to the clothing, furniture, &c.

The process for disengaging the oxygenated muriatic acid gas, in wards containing offensive sores and infectious diseases, is also extremely simple:—Four ounces of common salt, intimately mixed with two ounces of pulverised manganese, are introduced into a cup or small basin; to this mixture about two ounces of water are first added, and afterwards three ounces of the concentrated sulphuric acid in small portions at a time, each portion being sufficient to disengage such a quantity of gas as can be borne with ease by the patients in the room: when managed in this way, the smell of the gas is far from being offensive, and its effects in removing putrid and disagreeable smells much superior to any other means we have ever tried. (See the note, p. 397.) We do not, however, by any means deny the efficacy of the nitrous vapour: our principal objection to it, arises only from its ready condensation,
and

and the difficulty of diffusing it completely. But there is one circumstance on which the Doctor appears to place some reliance, the truth of which we very much doubt, and that is, that, during the disengagement of the vapour of the nitrous acid, a considerable quantity of pure air, or oxygene gas, is at the same time let loose; an opinion which is likewise supported by Mr. Keir. Now, from the generally received theory respecting the difference between the white and orange-coloured vapour, (and it is the last which is almost uniformly generated in close vessels, or where pure air is excluded,) a quite opposite effect should take place, that is, the production of the white vapour should be accompanied by a diminution of the oxygene gas in the room or apartment. In order to satisfy myself with regard to this fact, I made several experiments, the results of which were, that, when a cup containing a mixture of heated nitre and concentrated sulphuric acid was placed under a glass jar inverted over water, the air in the jar, after the nitrous vapour had been condensed, was found to have the proportion of its oxygene somewhat diminished, the difference being nearly as 93 to 90, or 31 to 30. This difference, which could not be perceptible in a large chamber, having only the usual quantity of nitrous vapour diffused through it, is but small, and I confess much less than was expected: it proves, however, that no oxygene gas is disengaged. In these trials the jar, after some time, was filled with orange-coloured vapours; and this never failed to be the case, where the heat of the materials, and strength of the sulphuric acid, were sufficient to disengage any quantity of nitrous acid. In the distillation of this acid, it is true, that a little pure air is disengaged towards the end; but this never happens until the bottom of the retort becomes red, and then the acid itself is decomposed, which can never take place in Dr. Smyth's process.

By giving a place to the preceding remarks in your valuable Magazine, you will greatly oblige

Yours, &c. &c.

Woolwich, May 12th,

W. CRUICKSHANK.

XI. *Report made to the French National Institute, by C. GUYTON and DARCEY, in regard to the Results of the Experiments of C. CLOUET, on the different States of Iron, and the Conversion of it into Cast Steel. From the Journal des Mines, No. XLV.*

THE memoir of C. Clouet is entitled Results of Experiments on the different States of Iron. He first treats of the combinations of iron and carbon. A thirty-second part of carbon, says he, is sufficient to convert iron into steel: a quantity of it equal to a sixth part of the weight of the iron, gives a steel more fusible and still malleable; but beyond that term it approaches to cast-iron, and has no longer sufficient tenacity. By increasing the dose of carbon you increase the fusibility, and it passes at length to the state of grey cast iron.

The particular kind of cast iron resulting from a combination of iron and glass, is the second object which engages the attention of C. Clouet. Glass never enters into it but in a very small quantity, yet its properties are changed. This iron, though exceedingly soft under the file, when brought only to a cherry-red heat, divides itself under the hammer; when poured into the ingot-mould, shrinks considerably; and when formed into plates, tempering gives them the grain of steel, and renders them more brittle, without giving them more hardness. Charcoal dust added to glass changes the result, and increases the fusibility; but the dose has a sensible influence on the products. From a thirtieth to a twentieth in one part of iron gives a very hard tempered steel, which suffers itself to be forged at a cherry-red heat, and which has all the properties of cast steel. By employing more carbon, you get only cast iron.

The affinity of iron for carbon is so great, that at a high degree of temperature it even takes it from carbonic acid. This he proves by the following experiment:—If you put into
a crucible

a crucible iron cut into small pieces, along with a mixture of equal parts of carbonat of lime and argil, expose them to the degree of heat necessary to weld iron, and maintain this heat for an hour or more, according to the size of the crucible; the metal when poured into the ingot-mould will be steel similar to cast steel.

The oxyds of iron are equally susceptible of passing to a state of soft iron, steel, and cast iron, according to the proportions of carbon employed. The black oxyd of iron, the state of which seems to be the most unalterable, becomes iron when treated in the crucible with an equal volume of charcoal powder: by doubling that quantity you will have steel, and a progressive augmentation gives it the characters of white and grey cast iron. In a word, C. Clouet observed the same transitions, and always depending on the respective quantities in treating cast iron and the oxyd of iron, cast iron and forged iron, the oxyd of iron and iron, the oxyd of iron and steel. A fifth part only of cast iron is necessary to render iron steel. The iron and the oxyd do not unite intimately; the black oxyd mixed with a half less of carbon than is necessary for its reduction, gives a soft iron, but not very tenacious, black and without a granulated fracture. A sixth part of the oxyd brings back common steel to the state of iron, by treating them together either in the forge or by cementation.

At the end of his memoir C. Clouet gives some observations on the method of producing cast steel, and the furnaces proper for that purpose. He determines the proportions of the substances to be fused; the degree of heat; the precautions to be employed in pouring them into the ingot-mould; the method of forging this kind of steel; the processes to be employed for assays, in a common forge, upon three or four pounds of matter; and the proportions to be given to a reverberating furnace to operate at the same time with four crucibles, containing each from twenty-three to twenty-six pounds of steel. He remarks, that ingredients of saline glass cannot

be employed with advantage; that glass, too fusible, renders steel difficult to be forged; that steel kept a long time in fusion, takes up more glass than it ought; and lastly, that the metal must be stirred, and the glass taken carefully away before it is poured out, in order that it may not mix itself with the steel. After giving a short view of the observations of C. Clouet, and the practical consequences which he deduces from them, it would have remained for us only to lay before you some specimens produced by his operations, had we not thought it our duty to add the results of the experiments which we made ourselves, by following his processes for the immediate conversion of iron into cast steel, and of which it is of importance that we should describe the principal circumstances.

The members of the Council of Mines having permitted us to make use of the forge constructed in their laboratory, we put into a luted Hessian crucible 6 hectogrammes (1.23 lb.) of the points of horse-shoe nails, and 4 (.81 lb.) of a mixture of equal parts of the carbonat of lime (white marble) and burnt clay, from a Hessian crucible, all reduced to powder. The mixture was heaped up to surround the iron fragments on every side; and the crucible placed upon its stand in the middle of the furnace, the heat of which was urged by three blasts. In our first trial we found, after about an hour and a half, that the matter was fused; but the crucible having burst, we were prevented from pouring it out. On repeating the operation at the same forge, and in the same manner, we obtained an ingot; a portion of which we now submit to the inspection of the Class. It forms a square bar, each face of which is from 26 to 27 millimetres (about one inch English).

The frequent and almost unavoidable accidents which crucibles experience by being exposed to the blast of bellows, made us think it a point of importance to ascertain whether the operation would succeed equally well in a reverberating furnace or any other wind furnace, as C. Clouet announces.

We

We first employed a Macquer's furnace in one of the laboratories of the Polytechnic School. Though its state of derangement did not give us reason to hope for the whole effect of the principles of its construction, a pyrometric piece placed in a separate crucible indicated that the heat had been carried to 151 degrees. The crucible did not appear to be either broken or cracked; yet the fusion was incomplete, and even a portion of the iron remained uncovered above the portion of the vitreous mass, without it being possible to discover the cause.

We then resolved to repeat the experiment at a founder's furnace; and C. Lecour, assayer of the mint, was so kind as to permit us to operate with that in his laboratory. Our success exceeded what we expected, considering the size of the furnace. A particular description of this operation appeared to us the best means of satisfying the demand of government, since it tends to establish the possibility of a manufactory of this kind on a large scale, and to give from observation the basis of this new art.

We repaired to the laboratory of C. Lecour in the mint, with our colleague Vauquelin, who assisted us in our experiments. The wind furnace is constructed of brick. The fireplace *a* is a square cavity of 25 centimetres (9.23 inches) on each internal face, 45 centimetres (16.62 inches) in height, terminated at the bottom by a grate *b* of seven square bars 27 millimetres (one inch) in thickness, and raised 25 centimetres (9.23 inches) above the bottom of the ash-hole. The mouth has an iron cover *c*, with hinges inclined about 25 degrees (see Plate IX.) from a perpendicular. The tunnel *dd*, by which the furnace is terminated, is built of bricks also. It commences above the aperture of the cover, and first forms a square, each face of which internally is equal to 25 centimetres; but it becomes narrower as it ascends, so that each face at the extremity is a fifth less. This tunnel rises, inclined against the wall, to the height of 13 decimetres (about four feet.) It is there connected with a large chimney raised about 15

metres (or 45 feet), the excess in the width of which is closed by a trap *e* moving on hinges when the furnace is at work. We had previously put into a Hessian crucible 15 centimetres (about $5\frac{1}{2}$ inches) in height, and 8 in diameter, 367 grammes (6914 grains) of small iron nails, and 245 grammes (4616 grains) of a mixture of carbonate of lime and burnt clay. This crucible was placed on its stand in the middle of the furnace.

At one of the corners of the bottom was placed a small crucible of kaolin with its cover, and containing two of Wedgwood's pyrometrical pieces, taken from two different boxes. We readily foresaw that in this position they would not receive the same degree of heat as the crucible placed in the centre; but it was a mode of estimation not to be neglected. The fire was kindled about half an hour after ten, and urged at first very slowly. At one o'clock we judged the fusion to be complete, took away the vitreous part, and poured the matter into the ingot-mould. A part of the matter remained fixed in the crucible, because too much time was employed in removing the last portions of the glass, and because perhaps a quarter of an hour more heat would have been necessary; but the moulded portion, by its form and grain, left no doubt of proper fusion, and of its perfect conversion into steel. The pyrometric pieces, placed at the corner of the furnace, gave one 136 degrees, and the other 140; from which it may be inferred, that the matter in the large crucible was exposed to a heat of about 150 degrees.

"Cast steel," says Perret in his Memoir which obtained the prize from the Society of Arts at Geneva, "is judged by most smiths intractable; but it is still possible to overcome it by attention and address." That of C. Clouet requires the same precautions, which depend on its peculiar nature; and it affords a proof that it may be forged, and that in this state, even though its grain be not rendered finer by tempering, it will bear a comparison with the English cast steel. We subjected also to trial, by forging, a small piece

obtained

obtained by fusion in a wind furnace: the grain of its fracture, after having been forged, fully confirmed the opinion which we formed of it when cast.

The ingots almost always exhibit on their fracture small cavities, which it might be supposed would produce faults in the forging; but as they are clear and free from all foreign matter, they form no obstacle to the union of all the parts. Besides, it will be easy to prevent this accident by a slower cooling in the ingot mould, which will naturally take place in operating upon larger masses. We ought not to omit that this steel, when forged into bars, is exactly in that state which Rinman indicates as one of the characters of cast steel. Its specific gravity is to that of the finest steel, not cast, in the proportion of 7.917 to 7.79.

However conclusive these results may be, it appears that something would still be wanting, if we did not at the same time produce a specimen of what an able hand, accustomed to manage the English cast steel, can do with ours in the fabrication of those instruments to which English steel gives so much superiority: we have the satisfaction of being able to exhibit this proof also of the utility of C. Clouet's discovery.

A bar of steel arising from the cast made at the *Dépôt des Machines du Conservatoire*, was delivered by C. Molard to C. Lepetitvalle, proprietor of the national manufactory of steel razors at the *Quinze-vingts, faubourg Antoine*. He made of it three razors, viz. two without any preparation, and one after having taken away the *apperçus* (the name given to the small fissures found at the surface and on the edges). This artist declares, that "the latter was manufactured with great facility, considering the quality of the metal; that it will bear comparison with those of the fine English steel named Marschall and B. Huntzman; and that all the three are excellent for any beard whatever."

Hitherto we have confined ourselves to an examination of

the processes and productions which have more particularly attracted the attention of Government; but we cannot terminate this report without pointing out, in a few words, the truths of the theory arising from them. It is well known that iron does not become steel, but by assuming about 0.2013 of its weight of carbon: here it is furnished only in the state of carbonic acid; this acid then is decomposed. This is a very important phenomenon, which the observation of C. Clouet has added to the proofs of the doctrine of the French chemists. But how is this decomposition effected?—It evidently results from the eventual or predisposing affinity which a portion of the iron exercises upon the oxygen of the acid, at the same time that the remainder of the iron tends to unite itself with the carbon; and a concurrence of these attractions produces a result which one would not have expected, and which would not indeed have been possible by simple affinity. Thus in this operation the vitreous flux is always seen charged with the oxyd of iron, the presence of which discovers itself by a very dark green colour. The experiment in which the iron was not fused, has enabled us to exhibit to you a proof of it. Hence it might perhaps be inferred, that this indispensable oxydation of a portion of the iron occasions in the product a decrease of so much the more importance, as iron only of the best quality can be employed in the operation. This consideration made us pay attention to the decrease, in order that we might at least give some idea of its probable limits. In the operation conducted at the wind furnace, the decrease was not altogether a twelfth; in another experiment made at the forge of the School of Mines, before C. Vauquelin, in 428 grammes of iron there was a loss only of 19 grammes, that is to say, less than a twenty-second part. We may then rest assured that this loss will be compensated by the value which the rest of the matter will acquire; and that, instead of increasing, it must be diminished when working on a large scale, for it is
evident

evident that it is produced chiefly by an accidental scorification, and always more in proportion to the surface than to the mass.

It now remains that we should still make, in regard to the process itself, a remark which seems proper to shew the superiority of it to all those hitherto used for the conversion of iron into steel. It is well known that the great difficulty is to make it take up the proper dose of carbon; below that you have soft steel; and above it, steel superaturated almost to the state of cast iron, and as refractory. Ought not the quantity to be determined here by the concurrence of the forces of the affinity which operate the decomposition of the carbonic acid? The degree of saturation would be then constant, and the product always uniform; and it may be readily comprehended how much value this condition, which we mention only as probable, would add to the new method.

From these reflections, and the facts mentioned in this report, we conclude, that the observations of C. Clouet on the different states of iron diffuse a new light over the manner of treating this metal; that the immediate conversion of soft iron into cast steel, without employing carbon, and by the decomposition of the carbonic acid, is a discovery as important for the advancement of the theory of chemical affinities, as it is valuable for increasing national industry; that, by the labours of C. Clouet, the processes of this new art are already determined, in such a manner as to leave no doubt of their succeeding in a large manufactory; that the steel arising from them, when forged in bars, has all the external characters and intrinsic qualities of the English cast steel of the manufactories of Huntzman and Marschall; that it may be used for the same purposes, and be introduced in competition with it into commerce, without fear of any distinction being made to its prejudice; that it is to be wished, in order to hasten the benefits of this discovery, that government would order from 15 to 20 myriagrammes to be manufactured of this steel, the value of which, at the present

price, would be almost equivalent to the expence; that entrusting the management of the first trials to C. Clouet, would ensure the best success; and lastly, that, in any event, the free and unreserved communication which C. Clouet has made of this discovery, entitles him to the gratitude of his countrymen, and to a national reward.

XII. *Extract of a Report made by C. PICTET, of Geneva, to the Society for the Advancement of the Arts established in that City in regard to the Steel-Yards of C. PAUL. From the Journal des Mines, No. XLV.*

THE place of inspector of weights and measures, occupied at Geneva by C. Paul, having given him an opportunity of carefully examining a great number of steel-yards, he has found reason to be convinced that the greater part of these instruments, and particularly the Roman steel-yards, are constructed on bad principles, and seem to have been made by artists unacquainted with the properties of the lever. He has succeeded in improving these instruments, and steel-yards in particular. The latter, in the common purposes of commerce, have two advantages over balances. 1. That their axis of suspension is not loaded with any other weight than that of the merchandise, the constant weight of the apparatus itself excepted; while the axis of the balance, besides the weight of the instrument, sustains a weight double to that of the merchandise. 2. The use of the balance requires a considerable assortment of weights, which causes a proportional increase in the price of the apparatus, independently of the chances of error which it multiplies, and of the time employed in producing an equilibrium. These motives induced C. Paul to employ his thoughts on the means of so far improving steel-yards, that, either in delicate operations of the arts, or in those of the same kind which are often so necessary in the practice of the physical sciences, these instruments

struments might be substituted with advantage for common balances. In order that I may better explain in what the improvements of the steel-yards submitted to the Society consist, it will be proper to point out what were the faults of the common ones.

1. There were none of them, in which the points of suspension were exactly in the prolongation of the line of the divisions of the beam; a circumstance which necessarily changed the relation between the arms of the lever, the power and the resistance, according as the direction of the beam was changed from a horizontal position. We have seen steel-yards, in which a degree only of difference in the inclination of the beam produced the difference of more than a pound in the result.

2. When the shell, the beam, and weight, are made at hazard, a person who possesses a steel-yard cannot know when the instrument is deranged; and even an artist cannot repair it, but by repeated trials, and with a great loss of time.

3. The construction of the common steel-yards, which have a small and a large side, renders it necessary to invert them frequently: a laborious operation when these instruments are heavy, and which exposes the axes to the danger of damage by the effect of the shocks which that turning occasions.

As these double sides renders it necessary to have a beam very straight, in order that it may be less faulty, it readily bends, which is a new source of error; and, the face which bears the numbers being narrow in proportion, it is difficult to form on it numbers sufficiently visible. These inconveniences are all avoided by the construction of C. Paul, which presents, besides, several other advantages not possessed by the old steel-yards.

1. The centres of the movement of suspension, or the two constant centres, are placed on the exact line of the divisions of the beam; an elevation almost imperceptible in the axis of the

the beam, destined to compensate for the very slight flexion of the bar, alone excepted.

2. The apparatus, by the construction of the beam, is balanced below its centre of motion; so that when no weight is suspended, the beam naturally remains horizontal, and resumes that position when removed from it, as also when the steel-yard is loaded and the weight is at the division, which ought to shew how much the merchandise weighs. The horizontal situation in this steel-yard, as well as in the others, is known by means of the tongue, which rises vertically above the axis of suspension.

3. It may be discovered that the steel-yard is deranged, if, when not loaded, the beam does not remain horizontal.

4. The advantage of a great and a small side (which in the others augments the extent of their power of weighing) is supplied by a very simple process, which accomplishes the same end with some additional advantages. This process is to employ, on the same division, different weights. The numbers of the divisions on the bar, point out the degree of heaviness expressed by the corresponding weights. For example, when the large weight of the large steel-yard weighs eighteen pounds, each division it passes over on the bar is equivalent to a pound; the small weight, weighing eighteen times less than the large one, will represent, on each of these divisions, the eighteenth part of a pound or ounce; and the opposite face of the bar is marked by pounds at each eighteenth division. In this construction, therefore, we have the advantage of being able, by employing both weights at once, to ascertain, for example, almost within an ounce, the weight of 500 pounds of merchandise. It will be sufficient to add what is indicated by the small weight in ounces, to that of the large one in pounds, after an equilibrium has been obtained by the position of the two weights, viz. the large one placed at the next pound below its real weight, and the small one at the division which determines the number of ounces to be added.

5. As the beam is divided only on one side, it may have the form of a thin bar, which renders it much less susceptible of being bent by the action of the weight, and affords room for making the figures more visible on both the faces.

6. In these steel-yards the disposition of the axes is not only such that the beam represents a mathematical lever without weight; but in the principle of its division, the interval between every two divisions is a determined and aliquot part of the distance between the two fixed points of suspension; and each of the two weights employed has for its absolute weight the unity of the weight it represents, multiplied by the number of the divisions contained in the interval between the two constant centres of motion. Thus, supposing the arms of the steel-yard divided in such a manner that ten divisions are exactly contained in the distance between the two constant centres of motion, a weight to express the pounds on each division of the beam must really weigh ten pounds; that to point out the ounces on the same divisions, must weigh ten ounces, &c. So that the same steel-yard may be adapted to any system of measures whatever, and in particular to the decimal system, by varying the absolute heaviness of the weights, and their relation with each other. The application of this principle will be seen hereafter in the description of the steel-yard, to which C. Paul, with great propriety, has given the name of *universal steel-yard*.

But, to trace out, in a few words, the advantages of the steel-yards constructed by C. Paul for commercial purposes, I shall only observe, 1. That the buyer and seller are certain of the correctness of the instrument, if the beam remains horizontal when it is unloaded and in its usual position. 2. That these steel-yards have one suspension less than the old ones, and are so much more simple. 3. That by these means we obtain, with the greatest facility, by employing two weights, the exact weight of merchandize, with all the approximation that can be desired, and even with a greater precision

precision than that given by common balances. There are few of these which, when loaded with 500 pounds at each end, are decidedly sensible of an ounce; and the steel-yards of C. Paul possess that advantage, and cost one half less than balances of equal force. 4. In the last place we may verify, every moment, the justness of the weights, by the transposition which their ratio to each other will permit; for example, by observing whether, when the weight of one pound is brought back one division, and the weight of one ounce carried forwards eighteen divisions, the equilibrium still remains.

If, instead of ascertaining the weight of the merchandise in pounds, you wished to find it according to the new system in decagrammes, hectogrammes and kilogrammes, it will be sufficient to substitute, for the ordinary weights, an assortment of three weights bearing the above names. These three weights are the decuple one of the other; and the absolute weight of that called kilogramme, is to the absolute weight of that called pound, in the exact ratio of these two quantities. It may be here seen, that, by adapting to the steel-yard a system of three weights, we may arrive at the second decimal, or the centiemes of the unity of the weights employed, and even without adding or changing any thing in the division of the beam.

It is on this simple and advantageous principle that C. Paul has constructed his *universal steel-yard*, which I am going to describe. It serves for weighing in the usual manner, and according to any system of weights, all ponderable bodies to the precision of half a grain in the weight of a hundred ounces; that is to say, of a decigramme in the weight of a kilogramme, or, in other words, of a ten thousandth part.

It is employed, besides, for ascertaining the specific gravity of solids, of liquids, and even of the air itself, by processes extremely simple, and which do not require many subdivisions in the weights. This complete apparatus is represented plate X.

The beam A B of this steel-yard is constructed on the same principles as the commercial steel-yard, but of much smaller dimensions *. The shears are suspended by a screw to a cross bar of wood supported by two pillars, which rest on the two extremities of a small wooden box furnished with three drawers, and which serves as the stand of the apparatus. This beam is divided into 200 parts, beginning at its centre of motion. The division is differently marked on the two faces: on the anterior face the numbers follow each other from 10 to 200, proceeding towards the extremity; and on the other face, represented apart at F, the numbers are marked in the opposite direction. I shall soon explain the use of this difference in the order of numeration.

The small frame G is destined to prevent the oscillation of the beam, and it is placed at the proper height by means of the nut and screw by which it is suspended. Above the beam is seen a small cross bar of brass, suspended by its two extremities from the cross bar of wood. Different weights are hooked to it, each having its particular value marked on it. And, in the last place, a small mercurial thermometer having the two most usual divisions, and destined to point out the temperature of the air and the water during the experiments. The axis of suspension of the steel-yard rests upon two beds of very hard well-polished steel. The case is the same, but in a reversed situation, with the axis which supports the hook C, that serves for suspending different parts of the apparatus according to the purpose to which it is to be applied.

When you wish to employ it as a common steel-yard, you suspend from it the brass shell E, which is an exact counter-balance for the weight of the beam when unloaded. The

* A drawing of C. Paul's Commercial Steel-yard was subjoined to this memoir. As it was impossible to give more plates, we have been obliged to suppress that figure; but the one we have caused to be engraved will give a very correct idea of it, since the principles of the construction of both the large and small steel-yards are absolutely the same. *Note of the French Editor.*

latter then assumes of itself a horizontal situation. You then search for the equilibrium of the substance put into this shell, by placing at the proper place, on the beam, the weight and its fractions corresponding with the system of weights adopted; and when you have found the equilibrium, you observe the weight indicated by the divisions on which each of the weights employed is found, exactly in the same manner as is done in regard to the common steel-yard.

There may be seen in the plate a glass shell suspended in a jar filled to a certain height with water. This shell is destined for experiments in regard to the specific gravity of solids. It is in equilibrium, if, when immersed into water at 12° R, as far as the junction of the three silver wires by which it is supported, it exactly balances the weight of the beam unloaded.

When you wish then to try the specific gravity of a solid, you first weigh it in air; but by putting it into the brass shell, and then substituting the glass one, you weigh it in water. It is well known that the difference of these weights, employed as a divisor of the total weight in air, gives for quotient the specific gravity. Care must be taken, as in all experiments of the kind, that no bubble of air adheres to that part of the apparatus immersed in the water, or to the substance, the weight of which is required, and which is immersed also.

The solid glass ball H is destined for the purpose of ascertaining the specific gravity of liquids, in the following manner:—This piece is furnished with a hook of fine gold, that it may be immersed without inconvenience in acids. When it is suspended to the hook of the steel-yard, and in the air, it is in equilibrium with the beam loaded at its extremity (either at the division marked O, on the side of the beam seen at F) with weights entitled *specific*, and $\frac{1}{100}$ of specific hooked on at the other.

This ball, immersed in distilled water at 12° R. as far as the end of the straight metal wire which suspends it, is still in equilibrium with these two weights placed in the following manner, viz. the large one at the division in the middle of
the

the beam marked *water* on the side F of the beam, and the small one at the division O, that is to say, the extremity. When the apparatus is thus prepared, you fill a jar with the liquid, the specific gravity of which you wish to ascertain; suspend the *ball* H to the hook of the steel-yard, and immerse it into the liquid till it rise exactly above the ring from which the ball hangs, observing the temperature, and disengaging carefully all the air bubbles that may adhere to the ball; then remove the small weight to the division O at the end of the beam, and convey the large one as far as that division, preceding that where the weight of the ball would raise the beam; and afterwards move the small weight as far as the division where the equilibrium will be restored, the beam being horizontal. Mark the division at which the large weight is found, and add two cyphers; to this number add the indication immediately resulting from the position of the small weight, and the sum of these two numbers gives the specific gravity of the liquid, or its ratio with the weight of distilled water to a ten thousandth part.

The balloon N is destined for trying the weight of any given kind of gas compared with that of atmospheric air, in the following manner:—The weight entitled *air tare* is arranged in such a manner that when placed in the notch, seen at the extremity of the beam beyond the divisions towards B, it forms an equilibrium with the balloon exhausted by the air-pump and suspended from the hook of the steel-yard. If the steel-yard is not then in equilibrium, it is a sign that the instrument is deranged, or that the vacuum is not perfect. The air, the relative weight of which in regard to atmospheric air you wish to ascertain, is to be introduced into the balloon, and the weight marked *air* is to be moved along the beam. The division at which it stands when an equilibrium is produced will indicate, in hundredth parts of the weight of the volume of atmospheric air that could be contained in the balloon, the weight of the gas actually inclosed in it.

This

This indication is read on the anterior part of the beam, where the words *atmospheric air* are marked.

Not satisfied with having procured to philosophers, and those fond of accurate experiments, an instrument extremely convenient for the closet, and of very extensive use, C. Paul has endeavoured to render this apparatus portable, and has constructed various pocket steel-yards, with which the nicest experiments may be made, and the quality of gold coin be ascertained by the trial of its specific gravity. They are constructed exactly on the same principles as the Roman small steel-yard, but are necessarily less extensive in their use. They cannot be employed, for example, in determining the specific gravity of an æriform fluid, and do not extend beyond 100 deniers of weight, (about 120 grammes;) but as they possess all the advantages of a balance, besides those peculiar to themselves, they are extremely convenient for philosophers who are obliged to travel.

EXPLANATION OF THE PLATE.

A, B, the beam of C. Paul's steel-yard with its divisions, commencing at the point of suspension. F, division of the other side of the same beam, commencing at the other extremity, or that farthest distant from the point of suspension. G, a small frame destined to prevent the oscillation of the beam. C, a hook from which the weights are suspended. E, a brass shell or basin. H, a ball of solid glass for trying the specific gravity of liquids. N, a glass balloon for trying the specific gravity of gases.

XIII. *A new, easy, and cheap Method of impregnating Water with Carbonic Acid Gas. Communicated by Dr. A. N. SCHERER, Counsellor of Mines to the Duke of Saxe Weimar.*

DR. FIERLINGER has proposed the following very simple method for impregnating water with carbonic acid gas.

gas. He fills common round bottles with water, inverts them carefully under water in order to prevent any air from entering, and charges them in the usual method with carbonic acid gas. He then corks the bottles, thus filled, under the water, with a ventilated stopper, immerses them under water in a proper cylindrical, almost tubular shaped vessel, 2 feet high, and of a proportionate width to the diameter of the bottle, in order to apply, by means of hydrostatic laws, a great pressure with a small quantity of water. The bottles thus filled with the gas, and entirely immersed, imbibe water by means of the affinity the carbonic acid gas has for it, in such a manner that they are nearly filled; and water is thereby obtained, impregnated with an equal volume of gas, the water having lodged itself in the interstices of the gas. It is pretty strong, and can be made still more so. This method has, besides its conveniency and cheapness, still other advantages; the degree of impregnation may be regulated by the height of the column of water under which the bottle is immersed, and the water is prepared in those vessels out of which it is to be drank, and this prevents that escape of gas which always takes place when poured from one vessel to another, especially if the water be strongly impregnated. The above-mentioned ventilated stoppers are corks fitted exactly to the bottles, perforated length-ways, by holes drilled through them, the uppermost orifices of which are covered with a small plate of pewter, fastened to the cork by means of a string passed through a hole in the centre, and drawn through the cork. If this small plate be furnished with a little cavity, in which iron filings are put, the water becomes chalybeate.

XIV. *Fifth Communication from Dr. THORNTON, Physician to the General Dispensary, relative to Pneumatic Medicine.*

A CASE OF ST. ANTONY'S FIRE CURED BY VITAL AIR.

MISS GOUDY, æt. 18, living No. 171, High-street, Shadwell, had been subject to occasional attacks of this disease for eight years past. In one attack, some years ago, a skin formed over the right eye, which was removed by a caustic powder blown into it by order of Mr. Sharp, and sight was restored in about a month: this eye has, however, since been subject to become inflamed upon the least cold, when the face enlarges prodigiously, looks red as fire, with intense burning. She had taken a great quantity of medicine under Messrs. Young, Ward, Evans, &c. without any marked advantage, previous to her parents making application to me. When I saw her, her right eye was much inflamed, and the upper lips and cheeks were tumefied in a frightful degree. It was a new case, that required much consideration. Were the vessels in a state of inflammation from tone, or from debility? Examining the arms I found them remarkably blue and mottled, the feet were always uncommonly cold, the appetite craving, or else none, very flatulent, great distention of the abdomen at times, and a tendency to chlorosis. The pulse small, and quick. I accordingly ordered the super-oxygenated air, November 27, 1798, gradually augmenting its power. Memorandum—December 4, Feels always a great glow over the whole body, after inhaling the vital air. Inflammation of the eye gone. I ordered a seton in the neck, to hinder a relapse, by its inviting the blood to a neighbouring part, and setting up a new action: and without fear I now pursued the tonic and stimulant plan, viz. bark, myrrh, and steel, and a super-oxygenated air *; and my fair patient was soon perfectly cured, and continues so, I am happy to say, to this day.

* The proportion was generally six quarts vital air mixed with twenty of atm o' p' e' ic.

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES,

LEARNED SOCIETIES.

GERMANY.

THE following question has been proposed as the subject of a prize by the Royal Society of Gottingen, to be answered before the first of November 1800.

As it has been ascertained by numerous experiments that a great quantity of vaporific (*caloris vaporifici*), or, as it is called, latent heat, is carried off by the steam of water, boiling in an open vessel, and soon dispersed, which, however, if carefully collected through tubes and pipes properly disposed, might be of great utility in various purposes in economy and manufactures, the Society embraces this opportunity of requesting mathematicians and philosophers to turn their attention to this subject, and to endeavour, as far as possible, to establish a more accurate theory than any yet given of the motion of steam.

The Royal Society requires, therefore, I. An investigation, both by experiment and calculation, of the laws, or at least the general laws, of the steam of boiling water passing through tubes of a certain length and size; the matter of the tubes and the degree of heat of the surrounding medium being given, as well as other data which it is not necessary to mention to those acquainted with the nature of this elastic fluid.

II. When these laws are in some measure established, to deduce from them what degree of heat can be communicated, in a given time, by a given quantity of steam thus conveyed through tubes, with a given quantity of cold water, or water of any given temperament.

The Electoral Jablownski Society of the Sciences, at Leipzig, have proposed the following questions, as the subject of a prize for the year 1799 :

HISTORY. An explanation, proved by authentic documents, of the origin, rights and principal destination of the dignity of Earl in the northern kingdoms.

MATHEMATICS. A more accurate determination, compared with experience, of the laws of resistance to fluid bodies impelling in an oblique direction.

PHYSICAL-ECONOMY. Application of our present knowledge respecting the different kinds of air, particularly to physics and economy.

The prize is a gold medal of the value of 24 ducats. No papers will be received but such as are written in French or in Latin ; and they must be accompanied with a sealed note, containing the author's name and place of residence.

The following is an account of the Sitzings of the Academy of Sciences of Berlin, in the year 1798 :

On the 11th of January M. Sellé read a German memoir on natural right ; and on the 18th M. Erman read one in French on literary blunders, and their influence on biography.

In the public sitting of Jan. 25th, M. Achard read, in French, an account of some experiments made with a view to determine the influence of compressed air on the germination of seeds, and its action on animal life, with the description of a new method of injecting the vessels of plants which are capable of receiving a fluid within them.—M. Denina read a French memoir on the ancient traces of the character of the Germans, followed by a short comparison between Marcus Aurelius and Frederic II.—M. Klaproth, a German memoir on the gold ore of Transylvania, and the new metal it contains.—M. Bastide, Researches, in French, on the word *environ*.—Count de Guyon, an historical view, in French, of the influence which women have had over the great actions of their age and country. This formed the third epoch.

On the 1st of February M. Wildenow read, in German, an essay on a new classification of the *mammiferæ*.

On the 8th M. Bode communicated several articles of intelligence from his astronomical correspondents. He presented also a memoir on the orbit of the comet observed at Berlin in 1797, which contained some results respecting its real course.

On the 15th M. Castillhon, Reflections, in French, on the senses in general, and particularly on the organs of the internal sense.

On the 22d M. Gedike, a paper, in German, on the reciprocal influence of civilisation on writing, and of writing on civilisation.

On the 8th of March M. Burja communicated a paper, in French, on the progress of light passing through a transparent prism, with an application to achromatic prisms, and achromatic telescopes.

On the 15th M. Ancillon presented a French memoir on presentation.

On the 22d M. Bastide presented, in French also, various observations on the French language, in regard to different passages of Montaigne, with some critical remarks on that author.

On the 29th M. Walter, the son, read a German memoir on the skin.

On the 19th of April M. Bode presented the eight first sheets of his celestial chart.

On the 3d of May M. Teller presented a paper, in German, on moral purism and empirism, and the ideas which ought to be formed of them.

On the 10th M. Cuhn, a paper, in German, on the history of the origin of the Germanic constitution.

On the 7th of June M. Achard, a German memoir, containing researches on the germination of seeds, and the growth of plants.

On the 14th M. Gruson, a paper, in French, on a new calculus, which he calls *calcul d'exposition*.

On the 21st M. Bieſter, a paper, in German, on the principle of Socrates, that virtue and knowledge (*φρονησις* et *επιστημη*) are the ſame thing.

On the 28th M. de Verdy, an historical chronology, in French, of the Margraves of Brandenburg, Anſpach, and Bayreuth, deſcended from the electoral houſe of Brandenburg, and who have exiſted ſince the year 1486 to the preſent time.

On the 2d of Auguſt M. Achard, a continuation of his experiments on the germination of feeds, &c.

On the 9th of the ſame month the academy held a public fitting, in which the following papers were read:—M. Achard gave an account of the experiments he had made to determine the influence of the coloured rays of light on the germination of feeds, the green colour of plants and their decay, and alſo to aſcertain the different degrees of the affinity of oxygen with luminous rays differently coloured. He ſhewed, at the ſame time, the apparatus which he employed, as well as the reſults of his experiments.—M. Erman read a memoir on the order of ſucceſſion in the houſe of Pruffia and Brandenburg, ſince the reign of the branch of Hohenzollern.—Count de Guyon read the fourth period of his historical view of the influence of women on the great events of their age and country. The fitting was terminated by a memoir of the marquis de Boufflers on literature and literary men.

HOLLAND.

The Batavian Economical Society, authoriſed by the Directory of the Batavian republic, has propoſed the following queſtion as the ſubject of a prize, to be answered either by natives or foreigners :

Are there any means hitherto unknown, and ſufficiently effective, to reſtore ſo completely, without the mixture of pernicious ingredients, the taſte and ſmell of ſtinking and corrupted water, as to render it a pure, cooling, and wholeſome beverage? And what are theſe means?

A ſatis-

A satisfactory answer to this question will entitle the author to a prize of 6000 florins. In the answer care must be taken, 1st, That the means be not too expensive, or attended with too much trouble; that they do not occasion too great a consumption of fuel; and that they can be employed at sea, on board vessels heavily laden, and often exposed to violent agitation.—2d, That the means do not require too much art, and may be easily applied, even by seamen.—3d, That they be proved by experiments capable of producing the same effects in every temperature.—4th, That they be not hurtful, by corroding the copper vessels in which ship's provisions are boiled, or in any other manner.

If the inventor of such means, after ascertaining their effect, will communicate his secret, without concealing any part of it, to the commissioner of the Society, so that it may be subjected to trial in any determined place or ship, and if it shall be found to answer after several experiments, he will receive a third part of the premium. The rest of the sum will be paid as soon as the Society have been convinced of the certainty of the result of these means, by experiments made in different climates, and by the opinion of competent judges.

The Society, however, retains to itself a right of dividing the prize among several competitors, should the means proposed by each be equally efficacious.

The papers are to be transmitted, with the usual formalities, addressed to C. J. J. Dessout at Harlem, Secretary General to the Batavian Society, before the 28th of February 1800.

SWISSERLAND.

The Economical Society of Berne, having received no satisfactory paper on the means of extirpating a destructive kind of moth, common there, which not only attacks woollen but also silk, and is particularly destructive to furniture stuffed with horse-hair, for which they offered a prize of 20 ducats in the years 1796 and 1797, again repeat the same question, and extend the time for receiving answers to three years.

The Society expect—1st, That the candidates will determine accurately whether this insect be the *tinea vestionella*, *pellionella*, *tapetzella*, or *sarcitella* of Linnæus, or different from these.—2d, A circumstantial natural history of it.—3d, An examination, founded on experience and scientific principles, of the efficacy of all the means hitherto proposed for extirpating it.—And lastly, A proposal, founded on experience and trials made, of means by which the destruction occasioned by these pests may in future be prevented. Papers on this subject may be transmitted to the Society any time before the 1st of January 1802.

FRANCE.

In the public sitting of the National Institute on the 4th of January, the following report was read of the labours of the Class of the Physical Sciences during the preceding quarter.

Among the various objects which for three months have occupied the Class of the Physical Sciences, were two new kinds of plants presented by C. Lheritier. The first, discovered at Madagascar by C. Bruguière during his voyage round the world with Kerguelen, will be distinguished by the name of *Bruguiera*. The second, discovered at the Isle of France by the same botanist, belongs to the family of the Orchis; as it is a parasite plant that entwines itself around the trunks of trees, C. Lheritier means, on that account, to call it *Rhizodendrum*.

There is a tree, originally from America, the young branches of which, while in a state of vegetation, are covered with a viscous matter, which, however slightly touched, adheres strongly to the fingers, and renders them black. C. Vauquelin considers it as a principle different from all those known in the vegetable kingdom; but which approaches nearer to the gums than to any other substance. The production of this sort of gum has made the name of *Robinia viscosa* be given to the tree in question, to distinguish it from another *robinia*, or false acacia, to which it has a great resemblance.

resemblance. C. Cels and Ventenat have shewn that this tree belongs to a species described by C. Jussieu and Lamarck. We are indebted to C. Mechain, associate of the Institute, for this new acquisition, still more important perhaps than that of the false acacia, which is at present cultivated with so much advantage.

The difficulty of collecting the various productions of different climates, has been justly considered as one of the greatest obstacles to the study and progress of natural history. This difficulty no longer exists in regard to the plants growing in the territories of Tunis and Algiers. The public is now in possession of a *Complete Flora of Mount Atlas*, so long wished for by botanists; and we are indebted for that obligation to C. Desfontaines.

C. Broussonet, whom the love of science conducted to the same part of Africa, has given an account of the particular processes employed at Fez and Tetuan, for preparing those goat skins of which morocco leather of different colours is manufactured.

C. Tessier has shewn how beneficial it would be to encourage, in the maritime provinces of France, the manufacturing of pitch-rope paper, such as that used for sheathing of ships, by employing oakum procured from old ropes, &c.

The same author has observed a singular fact, the cause of which is not yet known. He observed, in several places, milk newly drawn from the cow, and of a beautiful white colour, to become blue in the course of two or three days, and remain so even after it had been boiled. We are assured that this phenomenon does not depend either on the age or health of the cows, on the dairies, the vessels in which the milk is preserved, nor on any want of care or cleanliness. The whole produce of the milk, though blue, is of a good quality, and may be ate without any inconvenience. It is not improbable that this colour may be owing to some plants of the nature of woad or indigo, on which cows sometimes feed in summer. But this is only conjecture; and C. Tessier proposes,

proposes, with a view of discovering the truth, to make the necessary researches and experiments in those places where the phenomenon has been observed *.

In a memoir on a new classification of shells, C. Lamarck has shewn the necessity of increasing the number of genera, and of abridging the characters by which they are distinguished. This number he carries to a hundred and seventeen. Linnæus and other naturalists made it only sixty. By means of this classification, we may more easily reduce to its particular genus, all the testaceous animals with which we wish to be acquainted.

In the numerous family of the spiders there are some called miners and masons, because they construct for themselves subterranean cavities or galleries, which they shut with a kind of trap-door. C. Latreille, associate of the Institute, has pointed out the characters peculiar to this industrious family, and the means of preventing their being confounded with other insects of the same name, but of a different species.

It is well known that phosphorus, and several saline combinations of the phosphoric acid, have been found by chemists in urine. By new researches C. Fourcroy and Vauquelin have discovered, in that liquid, alumine and the phosphat of magnesia. They have seen that a peculiar animal matter, by which urine is characterised, and which gives it all its properties, forms there, very speedily, ammonia, which makes the phosphat of magnesia pass into the class of triple salts, renders it much less soluble than before, and susceptible of being precipitated in laminæ or crystalline needles. These two chemists have given an account of the spontaneous changes it experiences, and shewn that the examination of

* There seems more reason for suspecting it to be Prussian blue, the ingredients of which are furnished by all red blooded animals. We may observe, however, that it is a known fact that cows which eat the madder plant, give milk that has the appearance of being streaked with blood.

it, scarcely begun, is one of those objects which are highly deserving of the attention of physicians, since it affords the means of resolving one of the most important problems in regard to the physical condition of man, either in a state of sickness or health.

The observations of C. Beaumé on the decomposition of the muriat of lime by lime (*muriate calcaire par la chaux*), and his researches in regard to a disease called by physicians the black bile, the causes and effects of which have been explained by C. Portal, in pointing out the remedies by which it may be cured, have likewise engaged the attention of the class of the physical sciences.

ROYAL SOCIETY OF LONDON.

On the 5th of April the meeting was occupied with the reading of a paper on animal electricity, by Dr. Yeats. On the 12th and 18th a long paper on the Andaman Islands, by Capt. Blair, was read. On the 25th, some farther observations on hermaphrodites, by Everard Home, Esq. On the 2d and 9th of May, an ingenious paper by Count Rumford, on the weight of caloric, in which he repeats Dr. Fordyce's experiments, but with various results; and concludes, from all the experiments, that heat is imponderable. On the 9th there was also read a paper on the fecundation of plants, by Thomas Andrew Knight, Esq. On the 23d, and 30th, a paper on the different kinds of Asiatic elephants, with observations on their tusks and teeth, by John Corse, Esq.

DISCOVERIES IN AFRICA.

The following notice, on this subject, by Lalande, has appeared in one of the French Journals:

“Sir Joseph Banks, president of the Royal Society of London, has received intelligence from Horneman at Grand Cairo. His last letter was dated the 31st of August. Bonaparte offered him money. He set out with the caravan of Fezzan

Fezzan on the 12th of September, with camels, horses and some merchandise. He assumes the character of a merchant, but not very rich, that he may not afford temptation to avarice. When in Egypt he accidentally met with a countryman of his own, who had long resided there, and embraced the Mahometan religion. He had made three journeys to Mecca, and spoke the Turkish and Arabic languages with great fluency. He was on the point of returning to Europe; but, at the request of Horneman, he consented to accompany him on his journey. Horneman means to proceed to Fezzan, and thence to Cashna. He will remain as long as he can in the interior of Africa; and return either towards the west by Senegambia, or towards the east by Ethiopia. He still enjoys good health; has withstood the climate of the country, and is filled with zeal and ardour. His letter to Sir Joseph Banks bore the impress of Bonaparte's official seal, and was delivered to Sir Joseph by the French agent in England for the exchange of prisoners. Sir Joseph, in Von Zach's Ephemerides for February, does justice to the French by a compliment for the scrupulous delivery of this letter."

The following is an extract of a letter from *M. Horneman* to *Professor Heeren* at Gottingen, dated Cairo, October 14, 1797.—“ I am as well at present as can be expected; my health has not in the least suffered from the climate, though it is very different from that of Europe. I have not yet been able to examine thoroughly the ruins of Alexandria, because there are too many of the free Arabs roving about the city. But, in order that I might not be idle, I examined the different kinds of stones, and carried away specimens. It was no part of my plan to make researches into the antiquities in the neighbourhood of Cairo, until I had studied the language of the inhabitants. As I had a good opportunity, however, to visit the pyramids of Giza, I did not neglect it; and though the shortness of the time I could employ would not allow me to make many new observations, I received this
benefit

benefit from the excursion, that I am better acquainted with the country, and the easiest method of travelling through it.

“ I first ascended the great pyramid, and had got about a sixth part of the way towards the summit, when I was obliged to return that I might not detain my companions, M. Hope and Major Schwarz, who wished to enter it. This, however, we found impossible; because the entrance was choked up with sand, which it was necessary to remove. That we might not lose time, I proposed to Major Schwarz to take a walk through the neighbouring district, to examine the different kinds of stones. This we did with as much speed as possible, and returned in about an hour and a half. Before we came back M. Hope had been at the sarcophagus, but had again come out and returned to the vessel, which lay at the distance of about ten minutes walk from the large pyramid.

“ I now intend to go back with two of Murad Bey’s people, and to take a complete plan of all the pyramids, with the surrounding district, and a section of these edifices also, if possible; to go somewhat farther than other travellers have done; and, above all, to examine the springs in the large pyramid, which I consider to be difficult, but not impossible.

“ Just now (Oct. 1797) is the best time for travelling in Egypt. Peace every where prevails, for all are afraid of Murad Bey. An Englishman of the name of Brown seems to have taken advantage of this favourable period. Before he proceeded to *Darfoor*, he had been in Upper Egypt; at *Siwab* (the ancient temple of Jupiter Ammon), and the Lake Natron. He remained above two years at *Darfoor* without being able to procure leave to return, until he at length obtained it by an accident. People here say that he observes great silence, and therefore they scarcely know any thing of his discoveries.

“ There is at present an Abyssinian bishop here, of whom I have made several enquiries respecting Bruce. He informed me,

me, that an Englishman, *Jacobo Bruce*, had been in Abyssinia; that he was in great favour with the king and nobles of the country; that he frequently observed the sun with an instrument like that used by seamen; that he often asked respecting the *Sources of the Nile*, and that he at length undertook a journey thither. The bishop said that he had not been acquainted with this traveller himself; but that his father had known him personally, and had frequently spoken of him. This worthy bishop, therefore, has cleared Bruce of the accusation made against him, that he had never been at the sources of the Nile."

Under the head of discoveries in Africa, we are happy to announce, that the Public will soon be gratified with an account of Mr. Brown's travels into that little known quarter of the world. Mr. Brown some years ago went from Cairo to *Seetwab*, and in the ruins of *Oasis* there found the remains of a remarkable chapel, which he conjectures, and with some probability, to have belonged to the celebrated temple of Jupiter Ammon. He afterwards went along with the *Soudan* caravan, and paid a visit to the *Great Oasis* or *Alwab*, to which no European before him had ever penetrated; and which is laid down very accurately in Major Rennel's map, published in the *Proceedings of the African Association*. Mr. Brown then travelled through a desert of considerable extent, and at length arrived at *Darfoor*, in 15° 15' north latitude, which stands a little to the east of *Haraza* on the map above-mentioned. Here he found two cities, lying at the distance of two days journey of a camel from each other. One of them was the king's residence; the other was inhabited by merchants. In the latter of these cities he remained two years and ten months in an unpleasant situation, as he was often ordered to attend at court, and was not suffered to go to any distance from his habitation; owing to an accident, however, he at length found means to depart, and returned by the way of Egypt and Syria.

ASTRONOMY.

The transit of Mercury over the sun's disk is a phenomenon of the utmost importance to astronomy, as it affords the means of improving the theory and tables of that planet; but the late phenomenon of this kind, which took place on the 7th of May, was deserving of the more attention, as a transit of Mercury at the descending node of his orbit had never been observed in its whole duration. These transits, in general, are much more uncommon than those at the ascending nodes. Ever since mankind began to view the heavens, Mercury had been observed only three times under the like circumstances, and unfortunately each observation was incomplete. In the year 1661 the ingress of the planet into the sun was seen, but not its egress; and in the years 1753 and 1786 the egress only was observed. It is much, therefore, to be wished that the weather had been more favourable during the late transit, as the same phenomenon, under the like circumstances, will not occur before the year 1832. According to an observation made by a gentleman at Greenwich, on this transit, on Tuesday the 7th, with a seven feet telescope by Dr. Herschel, the aperture of which was contracted, the internal contact with the SW limb of the sun happened at $4^h 28' 32''$, and the egress at $4^h 31' 24''$ p. m. mean time. The ingress was not seen on account of the cloudiness of the morning.

Mercury has at all times afforded much occupation to astronomers; because, to observe that planet, is a matter of considerable difficulty. The great Copernicus died without ever having seen it, and therefore could believe only in its existence. The celebrated Maestlinus, the tutor of the immortal Kepler, used to say that this planet was calculated only to expose astronomers to the danger of losing their reputation: so that when he knew of any one employed in tracing out its intricate course, he advised him to employ his time on some better

better object. Riccioli calls Mercury a false deceitful star (*sidus dolosum*), the eternal torment of astronomers, which eluded them as much as the terrestrial mercury did the alchemists*. Lalande, that respectable veteran of astronomy, who has forty-six years engaged with this celestial rebel, in his last treatise on it, in the first volume of the Transactions of the National Institute, calls its course *une orbite inextricable*. On account of this planet he studied the Greek language, that he might be able to read the old observations in Ptolomy's Almagest in the original, and, of course, to explain them better; and in the younger part of his life he used to get on the tops of the houses, before sun-rise, to have a view of Mercury above the foggy horizon of Paris. It is natural, therefore, to suppose, that, after so much labour and exertion, Lalande would have given the best tables of Mercury; and this was really the case, so far as they surpassed in accuracy the old tables of Halley and Cassini. He waited, therefore, with anxious expectation for the transit of this planet over the sun's disk on the 4th of May 1786. His observations on that occasion were to be the touchstone of his tables, and to reward him at length for the incessant pains and labour he had bestowed on them for nearly half a century. The treacherous Hermes, however, instead of sanctioning these tables, proved that the author had erred more than half an hour†. Since that time Triesnecker of Vienna, and lately Oriani of Milan, have employed themselves on this planet: and as the last, in particular, first calculated the per-

* *Almagestum*, p. 563: Nemo planetarum—Mercurio implicatio est—adco ut cœlestis Mercurius non minus Astronomos torserit, quam terrestis Alchemistas eludat. And in another place, p. 498, he says—Non minoribus quippe spirarum involucribus vaserrimus planetarum suffuratur se hic Hermes Astronomorum conatibus, quam caduceus ipsius tortuosis anguium circumflexibus.

† Lalande's own words are—*Une erreur de plus de demi-beure vint me égarer un dementi.*

turbation, according to La Place's theory; Lalande, in the year 1796, improved his elements of Mercury's orbit, and published them in the *Connoissance des Temps* for the year VII, in the certain hope and expectation that he had at length overcome this intractable planet, and could with Virgil exclaim: *Respexit tamen et longo post tempore venit.*

Much, however, was still wanting; and we are happy to inform those fond of astronomy, that a respectable astronomer, Major von Zach, has just announced a complete new set of tables of Mercury, in which not only the perturbations of Venus, calculated by Oriani, but those also occasioned by the earth in Mercury, and which Oriani has omitted, will be taken into account. An exalted amateur of astronomy is employed in calculating them, and they will be printed at his expence. Major von Zach informs us also, that he will have the pleasure of transmitting them to all the astronomers in Europe. As these tables are not intended for the booksellers' shops, every person fond of astronomy, who wishes to procure a copy of the work, will receive one gratis, on applying to Major von Zach at Gotha.

BOTANY.

A singular and ingenious method of multiplying the tongue-leaved eucomis or fritillary (*Fritillaria regia*, L.) is described in Professor Hedwig's Collection of Memoirs and Observations on Subjects of Botany and Economy. This fritillary is called, by Lamarck, *Basile à épi couronné*. When this beautiful plant of the lily kind is in full flower and vigour, the flowers, leaves, and the upper part of the bulb must be cut, and wrapped up in several folds of sized writing paper, so that the whole be exactly covered. They are then to be moderately compressed between two pieces of board; and at the end of some months several small bulbs will be seen formed at the lower extremity. I cultivate, says C. Willemet, who has made known the above observation,

this charming unilobed plant in the national botanic garden at Nancy. It requires to be kept during winter in the hot-house.

MEDICINE.

Doctor Lentin, a celebrated physician of Germany, has lately published, in the Transactions of the Royal Society of Gottingen, some observations on Caries of the Bones, and the cure of that disease. In his opinion it depends on a chemical decomposition of the phosphat of lime, produced by the putrefaction of the gelatinous matter contained in the bones. In consequence of this idea, he was authorised to believe that the phosphoric acid administered externally might be useful in that disease; and experience, from what he relates, seems to confirm it. He gives internally from ten to twenty drops in any proper vehicle; and externally, one part of the same acid with seven parts of distilled water. He says, he observed that the peculiar fetid odour of carious bones was in a little time removed, and that a cure speedily followed. He, however, adds, that persons afflicted with hemorrhoidal symptoms, as well as women when subject to their courses, were a little irritated by this remedy.

Knaksted has published, in the Memoirs of the Institute of Petersburg, for the treatment of the sick, that the root of common elecampane (*Inula helenicum*), given both internally and externally, is a very efficacious remedy for tetters, the itch, and other cutaneous diseases.

INDEX TO VOL. III.

- ACADEMY of Sciences at Berlin*, fittings of the, page 420.
Acetic acid, frozen by artificial cold, 79.
Achard's experiments respecting the effects of electricity on vegetable and animal substances, 51.
Achard's way of extracting sugar from beet roots, 291.
Africa, discoveries in, 427.
Agenda, for a theory of the earth, 33, 147, 294.
Air, on the means of purifying in sick apartments, 258.
Allen and Pepys's experiments on artificial cold, 76.
Analysis of the spinel ruby, 41.
Anatomy, researches concerning, 108.
Animals and Plants, on the winter sleep of, 156.
Animals, found alive in stones and other solid substances, 225.
Antiquarian Society of London, a present to the, 106.
Antiquities, intelligence relating to, 107.
Apple trees, to destroy insects prejudicial to, 89, 224.
Astronomy, intelligence relating to, 110, 324, 431.
Astronomy, history of, for 1798, by Lalande, 381.
Attar, or essential oil of roses, process for making, 347.
Aurum musivum, process for preparing, 319.
Barometer, effects of the moon on the, 125.
Batavian Economical Society, prize question by the, 422.
Beckmann on Naples yellow, 278.
Beckmann on staining of wood, 54.
Beet roots, to prepare sugar from, 291.
Bernoulli, James, biographical memoirs of, 92.
Birds of prey, their attachment to their young, 176.
Births, 329.

- Blumenbach*, on negroes, page 141.
Bolides or fire-balls, Fulda's observations on, 66.
Bolton's, Captain, machine for drawing ship bolts, 189.
Bolts, a machine for drawing in and out of ships, 189.
Bones, Turkish method of setting fractured, 127.
Books, account of new, 99, 319, 321, 323.
Botany, an ingenious method of multiplying the *Fritillaria regia*, L. 433.
British Mineralogical Society, institution of the, 318.
Brown's process for preparing manure, 32.
Bruguiere and Olivier, travels in Turkey, Egypt, &c. by, 337.

Carbonic acid gas, simple way to impregnate water with, 416.
 ——— decomposable by iron in fusion, 402.
Cast-iron, on the materials used in the manufacture of, 13.
Cast-steel, Clouet's new process for making, 400.
Cassan's description of the volcano in St. Lucia, 1.
Charcoal, process employed in making, 15.
Chaff, an improved machine for cutting, 292.
Chladni's theory of sound, experiments relating to, 389.
Cloth, a new kind of manufacture of, 110.
Coaks, process employed for preparing, 20.
Cold, artificial, singular experiments on, 76, 110.
Contagion, on the gases which destroy, 396.
Contagious diseases and fever, Mitchillian theory of, 177.
Cornwall, a vein of silver discovered in, 111.
Corruption hastened by electric matter, 51.
Corse's account of the method of catching elephants, 5.
Cow-pox, Dr. Pearson's circular letter respecting the, 223.
Cronstedt on the attachment of birds to their young, 176.
Cruikshank, chemist to the ordnance, a communication from, 396.
Custance's machine for making vegetable cuttings for the microscope, 302.

Deaths, 112, 329, 332.
Diaphanometer to determine the quantity of vapours existing in any limited part of the atmosphere, 377.
Dinner, account of a public Egyptian, 85.
Diving machine, description of a new one, 59, 171.

Earth, hints for a theory of the, 33, 147, 294.
Economical Society of Berne, prize question by the, 423.
Egypt, letters from men of science in, 84.
Egyptian Institute, 84, 88.
Electoral Jablounski Society, prize questions by, 420.
Electricity, effects of, on vegetable and animal substances, 51.
Elephants, account of the method of catching, 5, 130.
Engravings or prints, to cleanse and whiten, 260.

- Essential oil of roses*, process for making, page 347.
Eton's observations on the British trade with Turkey, 262.
Eudiometer, description and use of Guyton's, 191.
Fabbronì's method of cleaning and whitening prints, 260.
Fabricius on the winter sleep of animals and plants, 156.
Fermentation, electrical experiments on, 51.
Fever and contagious diseases, Mitchillian theory of, 177.
Fierlinger's process for impregnating water with carbonic acid gas, 416.
Fiery eruption, a remarkable one from the earth in Iceland, 114.
 ——— in Greenland, 119.
Fire-balls, Fulda's observations on, 66.
Frigorific mixture of muriat of lime and snow, experiments with, 76, 110.
Frogs and toads found alive inclosed in stones, &c. 225.
Fractured bones, Turkish method of setting, 127.
France, National Institute of, 424.
Frost bitten limbs, Russian method of treating, 128.
Fulda's observations on fire-balls, 66.
Gases, apparatus for weighing, 408.
Geographical intelligence, 109.
Georgi on the Swedish stone paper, 158.
Gravitation, experiments on, 321.
Greenland, a fiery eruption in, 119.
Guyton's eudiometer, description and use of, 191.
Hassenfratz on the oxygenation of snow and rain, 233.
History, prize question relating to, 420.
Hooke, Robert, his discoveries prior to Mayow, 370.
Human race, comparison between, and that of swine, 284.
Hurland mine, silver discovered in, 111.
Iceland, account of the fiery eruption there, in 1783, 114.
Imperial Academy of Sciences at Petersburg, transactions of, 99.
Infection, Mr. Cruickshank on the gases which destroy, 396.
Infectious diseases, Mitchillian theory of, 177.
Ink, a new kind of sympathetic, 375.
Insect, on a new one prejudicial to apple trees, 89, 224.
Institution, a new one established in London for diffusing knowledge and facilitating the introduction of mechanical inventions, 216.
Intelligence, 103, 216, 312, 419.
Iron, on the materials used in the manufacture of cast, 13, 193, 239.
Iron, on the primary ores of, 350.
Iron in the blood, observations relating to, 103.
Iron ore, a singular kind found in Shropshire, 320.
 Ff 3

Iron, experiments of the French chemists on the different states of,
page 400.

Iron-stones, how generally disposed in the earth, 24.

———— the mining of, 28.

Island, a new one thrown up in the sea, 118.

Klingert's diving machine, description of, 59, 171.

Lacsha or Lac insect, description of the, 367.

Lalande's history of astronomy for 1798.

Lantern, discovery of one to be used under water, 175.

Learned Societies, intelligence concerning, 84, 103, 216, 312, 419.

Levant trade, observations on the, 262.

Ligurian National Institute, establishment of the, 105.

Manure, to prepare from vegetables, 32.

Marriages, 329.

Mathematics, prize question in, 420.

Mayow's discoveries anticipated by Hooke, 370.

Medicine, 90, 213, 299, 434.

Melancholia cured by inhaling vital air, 300.

Mercury, an experiment in which 56 lbs. were frozen into a solid
mass, 76.

Mercury, account of the transit over the sun's disk on the 7th May
1799, 431.

Meteorology, 120, 332.

Mexico, a singular old custom in, 126.

Meyer's new sympathetic ink, 375.

Microscope, machine to prepare cuttings for the, 302.

Mineral waters, new process for preparing artificial, 416.

Mineralogical Society of Jena, anniversary of, 317.

Mineralogy, intelligence relating to, 111, 317, 318, 320.

Mitchillian theory of fever, a short view of the, 177.

Mons, Van, on purifying the air in sick apartments, 258.

Moon's influence on the weather, 120.

Mortification, an incipient, cured by vital air, 191.

Murhard on living animals found inclosed in stones, 225.

Murhard's description of Saussure's diaphanometer, 377.

Muriatic acid, does not freeze at 50° below 0°, 79.

Musket on the manufacture of cast-iron, 13, 193, 239.

Musket on the primary ores of iron, 350.

National Institute of the Ligurian republic, 105.

———— of France, 424.

———— of Egypt, 84, 88.

Naples yellow, history of, and methods of preparing, 278.

Negroes, bodily conformation and mental capacity of, 141.

Nitric acid, attempt to freeze, 79.

Nitrous vapour, observations on fumigations made with, 398.

- Oedmann's* account of a Turkey cock hatching eggs, page 309.
Olivier and Bruguiere, travels in Turkey, Egypt, &c. by, 337.
Oxygenated muriatic acid, methods to prepare, 260.
Oxygenated water, snow determined to be, 233.
Oxygen gas, cures effected by inhaling, 90, 213, 299, 418.
Oxygen in the blood, observations on, 104.
Oxygenated muriatic acid gas employed to destroy contagion, 397.

Paper, to prepare, that will resist fire and water, 158.
Paul's improved steel-yard described, 408.
Pepys and Allen's experiments on artificial cold, 76.
Phosphorescence of wood, remark concerning, 321.
Physiology, Carradori's experiments in, 322.
Plants, to preserve the seeds of, 30.
Plants, on the excrement of, 319.
Plants and animals, on the winter sleep of, 156.
Poller's account of the process for making attar, 347.
Potters' earth, on the kind called sea-froth, 165.
Prediction, one current in Egypt, (see note) 342.
Prints or engravings, to cleanse and whiten, 260.
Prize questions, 312, 419.
Putrid smells, removed by oxygenated muriatic gas, 398.

Rain and snow, their influence on vegetation, 233.
Reinegg, on the so called sea-froth, 165.
Rollo's, Dr., account of Sauffriere, 256.
Ropes, an improvement in the fabric of, 331.
Roses, essential oil of, process for making, 347.
Roxburgh's description of the Lac insect, 367.
Royal Academy of Sciences at Copenhagen, prize questions, 312.
Royal Society of London, proceedings of, 105, 216, 427.
Royal Society of Gottingen, prize question by the, 419.
Ruby, the spinel, analysis of, 41.

Salmon's machine for cutting chaff, 292.
Sanmartino's method of preserving trees from being hurt by frost,
310.
Sauffure's Agenda for a theory of the earth, 33, 147, 294.
Sauffure's diaphanometer, description of, 377.
Scrophula, cured by inhaling vital air, 90.
Sea-froth, on the so called, 165.
Seeds, to preserve in a state fit for vegetation, 30.
Ship-bolls, description of a machine for drawing, 189.
Silver, a vein of, discovered in Cornwall, 111.
Sleep of animals and plants in winter, 156.
Smyth's, Dr., Treatise, an error in the last edition of, 396.
Sneyd's method of preserving seeds of plants, 30.
Snow and rain, their influence on vegetation, 233.

Snow found on the Alps, of a red colour, by Saussure, page 168.

Souffriere in St. Lucia, description of, 1, 256.

Sound, experiments relating to Chladni's theory of, 389.

Spinel ruby, Vauquelin's analysis of the, 41.

Spirit of turpentine, attempt to freeze, 79.

Spring of water, description of a remarkable, 49.

Staining of wood, Beckmann's experiments on, 54.

Statistics, intelligence relating to, 109, 329.

Steam of water, prize question concerning, 419.

Steel, a new process for making, by Clouet, 400.

Steel-yards, an improved one by C. Paul, 408.

St. Antony's fire, a case of, cured by vital air, 418.

Stuff, a new kind of manufacture of, 110.

Sugar, to prepare from beet roots, 291.

Sulphat of strontian, quantities of, found near Bristol, 321.

Sulphureous acid gas, method of fumigating with the, 397.

Sulphuric acid, frozen by artificial cold, 79.

Suphuric ether, does not freeze at 50° below 0°, 79.

Surgery, present state of, in Turkey, 127.

—— Russian method of treating frost bitten limbs, 128.

Swedish stone-paper, on the composition of, 158.

Swine, comparison between them and men, 284.

Sympathetic ink, a new one, 328.

Sympathetic ink, a new kind by Meyer, 375.

Teylerian Society, prize questions by the, 315.

Thornton's, Dr., Communications on pneumatic medicine, 90, 213, 299, 418.

Thornton, Dr., on objects for the microscope, and on Cuffance's machine for making vegetable cuttings, 302.

Thornton, Dr., on Hooke's discoveries relative to air, 370.

Toads and frogs found inclosed alive in stones, &c. 225.

Toaldo's system respecting changes of weather, 120.

Tradition, a curious one in Egypt, (see note) 342.

Travels in Turkey, Egypt, Persia, in 1792, &c. 337.

Trees, to preserve from being hurt by frost, 310.

Turkey, present state of surgery in, 127.

Turkey trade, observations on the, 262.

Turkey cock, instance of eggs being hatched by a, 309.

Turkish tobacco pipes, on the manufacture of, 165.

Vauquelin's analysis of the spinel ruby, 41.

Vegetation, to preserve seeds in a state fit for, 30.

Vegetables, to convert speedily into manure, 32.

Vibrating surfaces, on the figures formed with sand, &c. on, 389.

Voigt's experiments relative to Chladni's discoveries in sound, 389.

Volcano in the island of St. Lucia, description of, 1, 256.

- Water*, easy way to impregnate with carbonic acid gas, page 416.
Water, prize for the best means of restoring the salubrity of corrupted and stinking, 422.
Weather, Toaldo's system respecting changes in the, 120.
Weeds, to convert speedily into manure, 32.
Weighing instrument, description of an improved, 408.
Winter sleep of animals and plants, 156.
Wood, component parts of some varieties of, 17.
Wood, experiments on staining, 54.
- Yellow, Naples*, history of, and methods of preparing, 278.

END OF THE THIRD VOLUME.

ERRATA.

Page 15, l. 24, for *craters* read *crater*.——P. 22, l. 22, for *carb.* 3·65, read *carb.* 3·615.——P. 23, l. 15, after *elegances*, add *of life*.——P. 25, l. 20, for *Lancashire*, read *Lanarkshire*.——P. 25, l. 16, after *assay*, insert *furnace*.——P. 28, l. 9, for *formed*, read *found*.——P. 29, l. 6, read, accompanying *schiste* and rubbish.

The Binder is desired to notice, That the Plates in No. XI. for April, are wrong numbered in some Copies. Plate VII. ought to be Plate VI. and the Quarto Plate marked VIII. should be Plate VII.

Fig. 7.

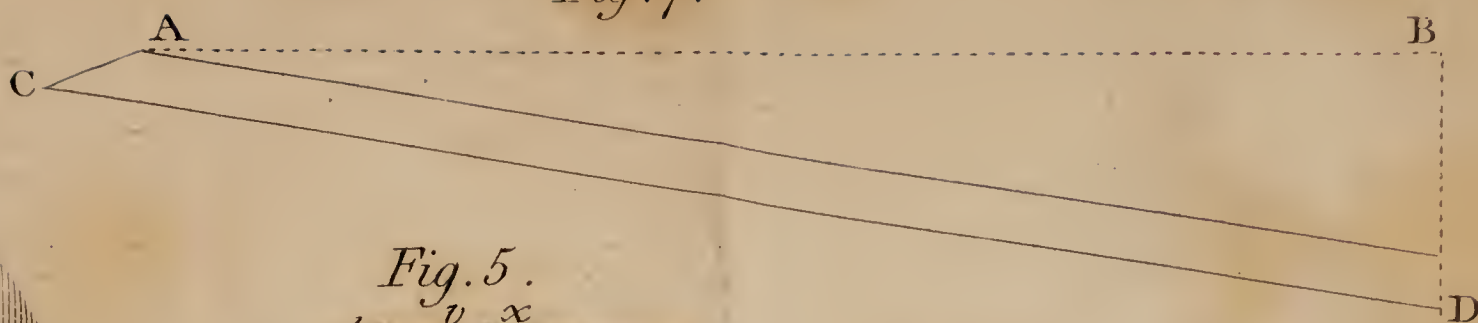


Fig. 1.



Fig. 5.

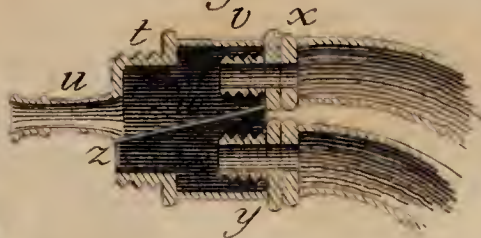


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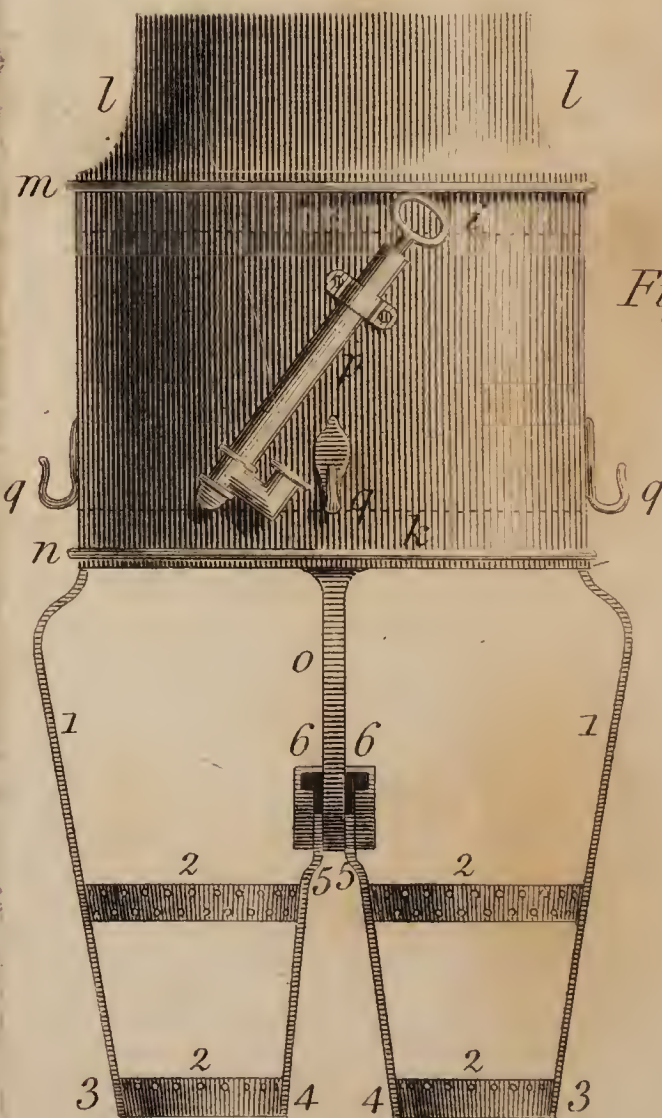
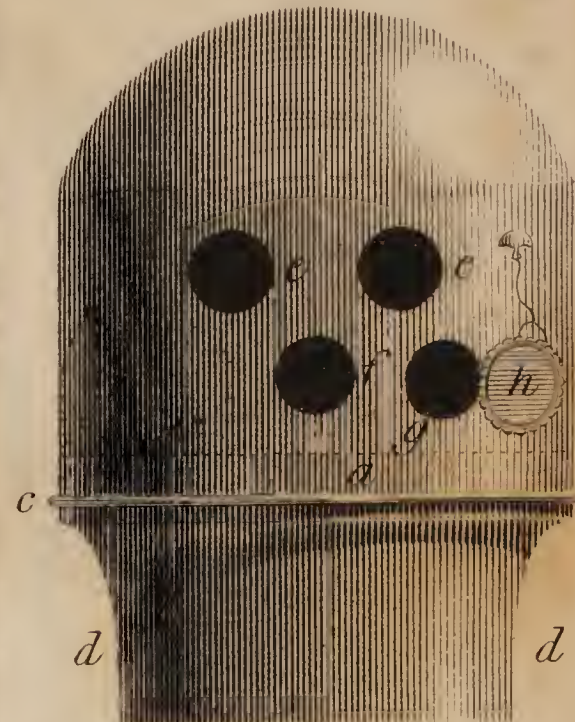


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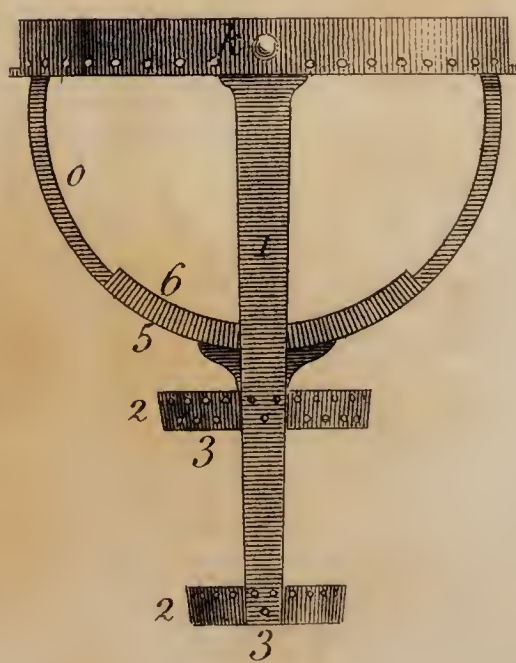


Fig. 4.



Fig 1

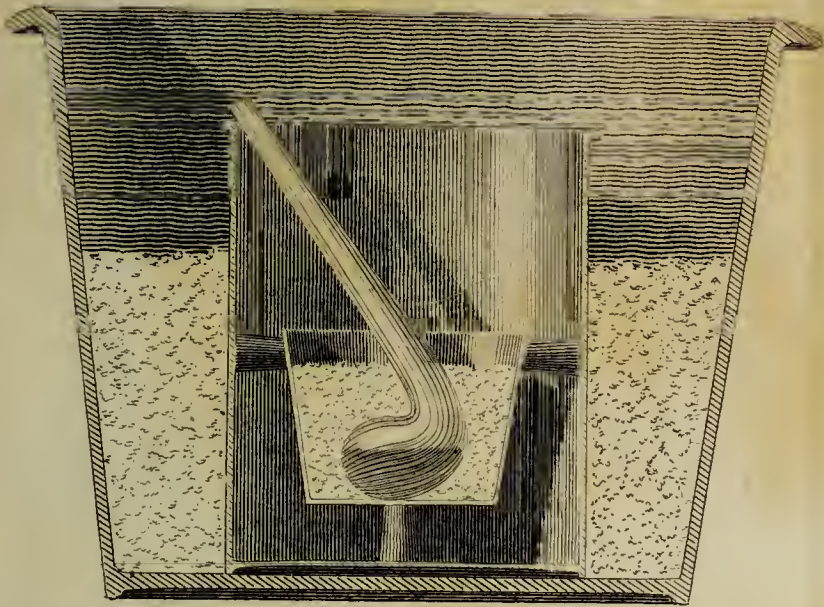
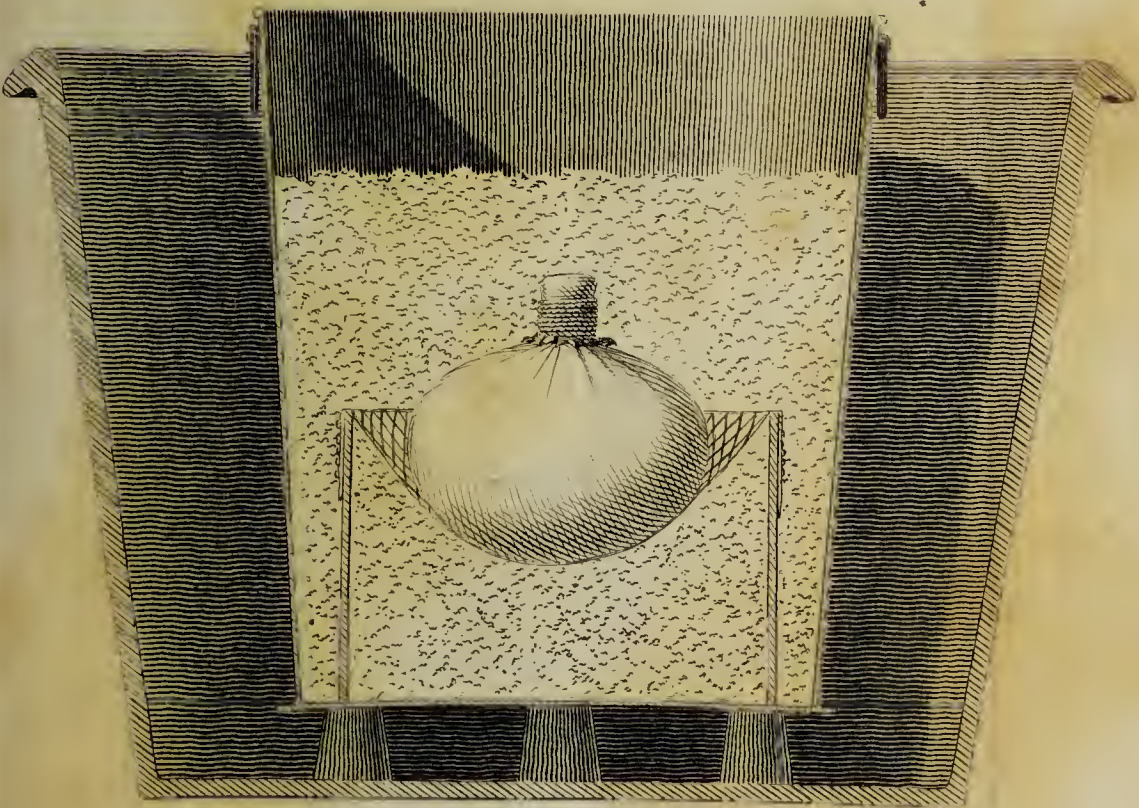
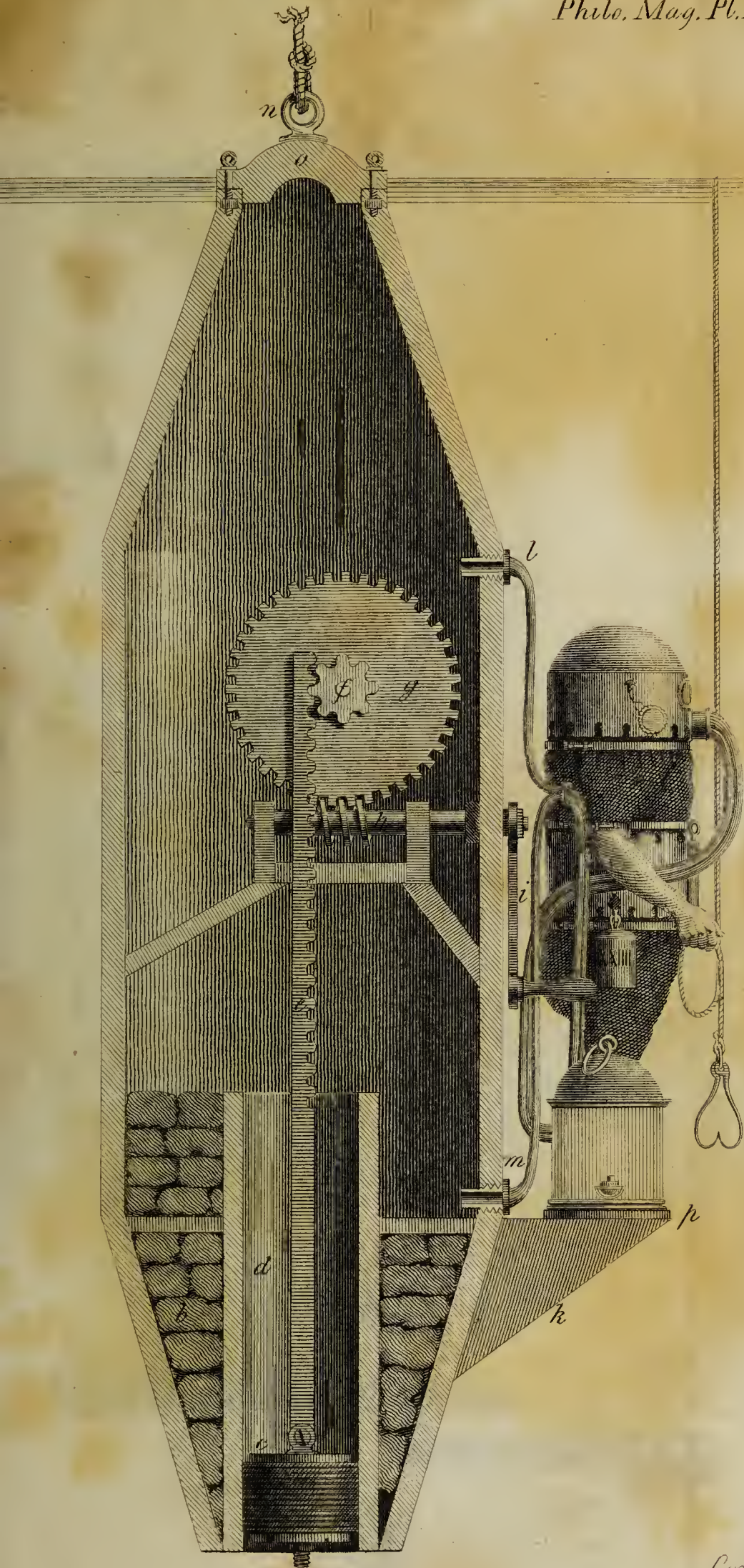
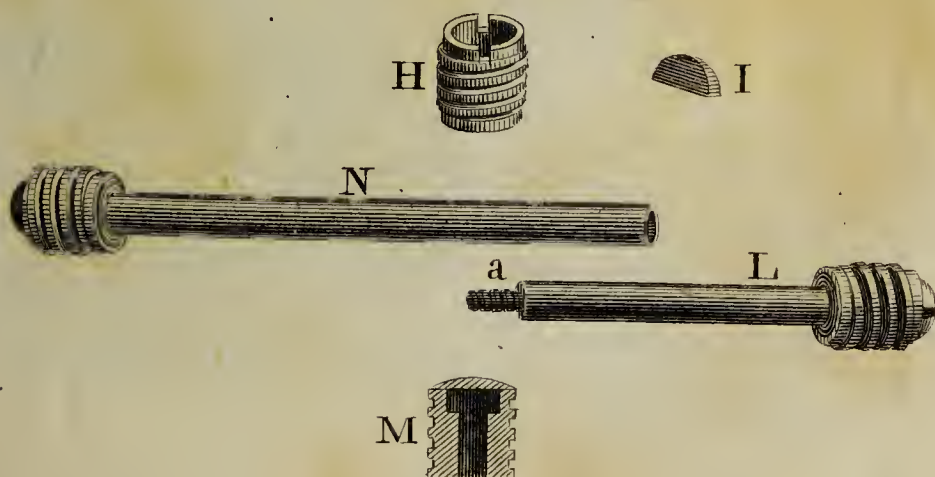
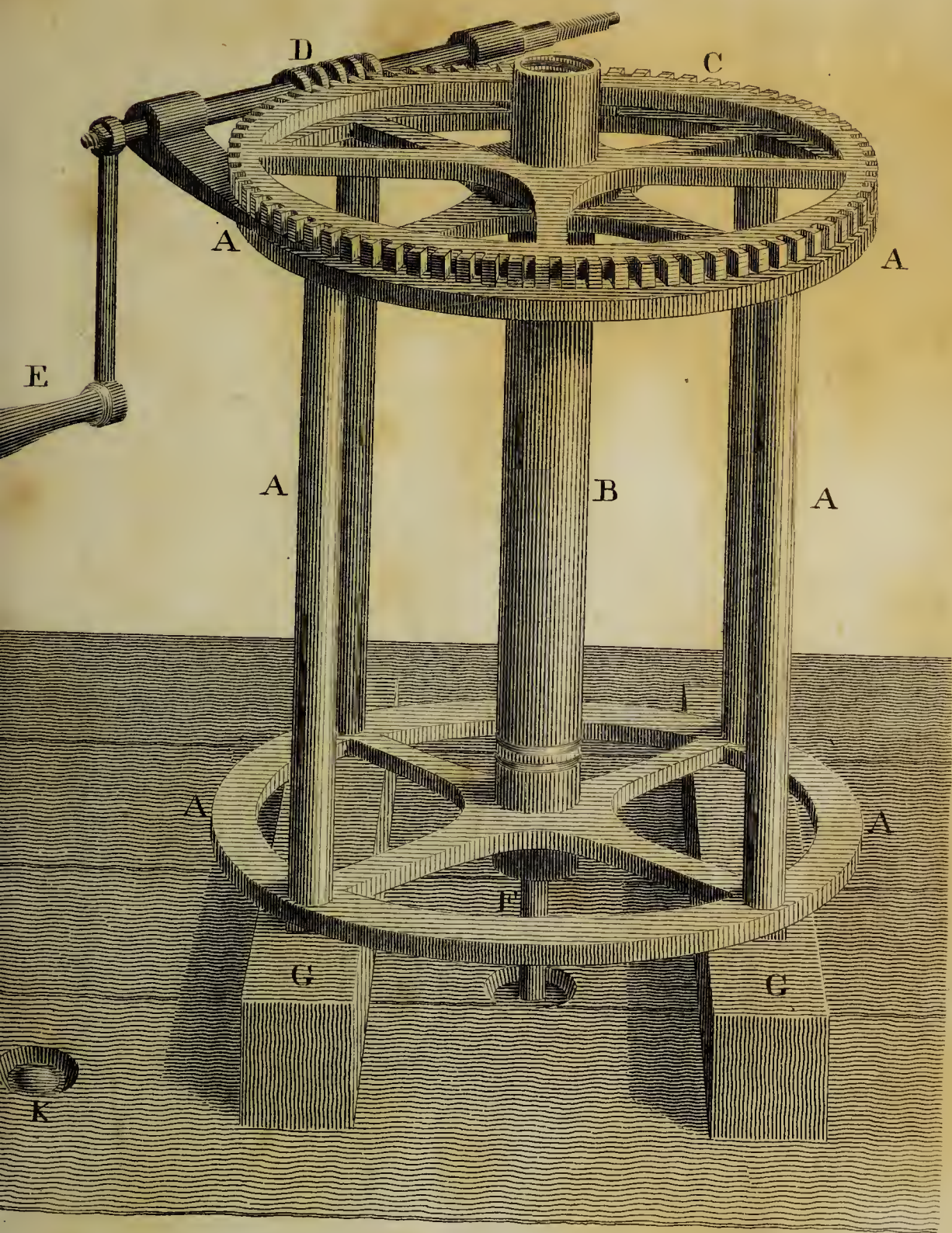


Fig 2









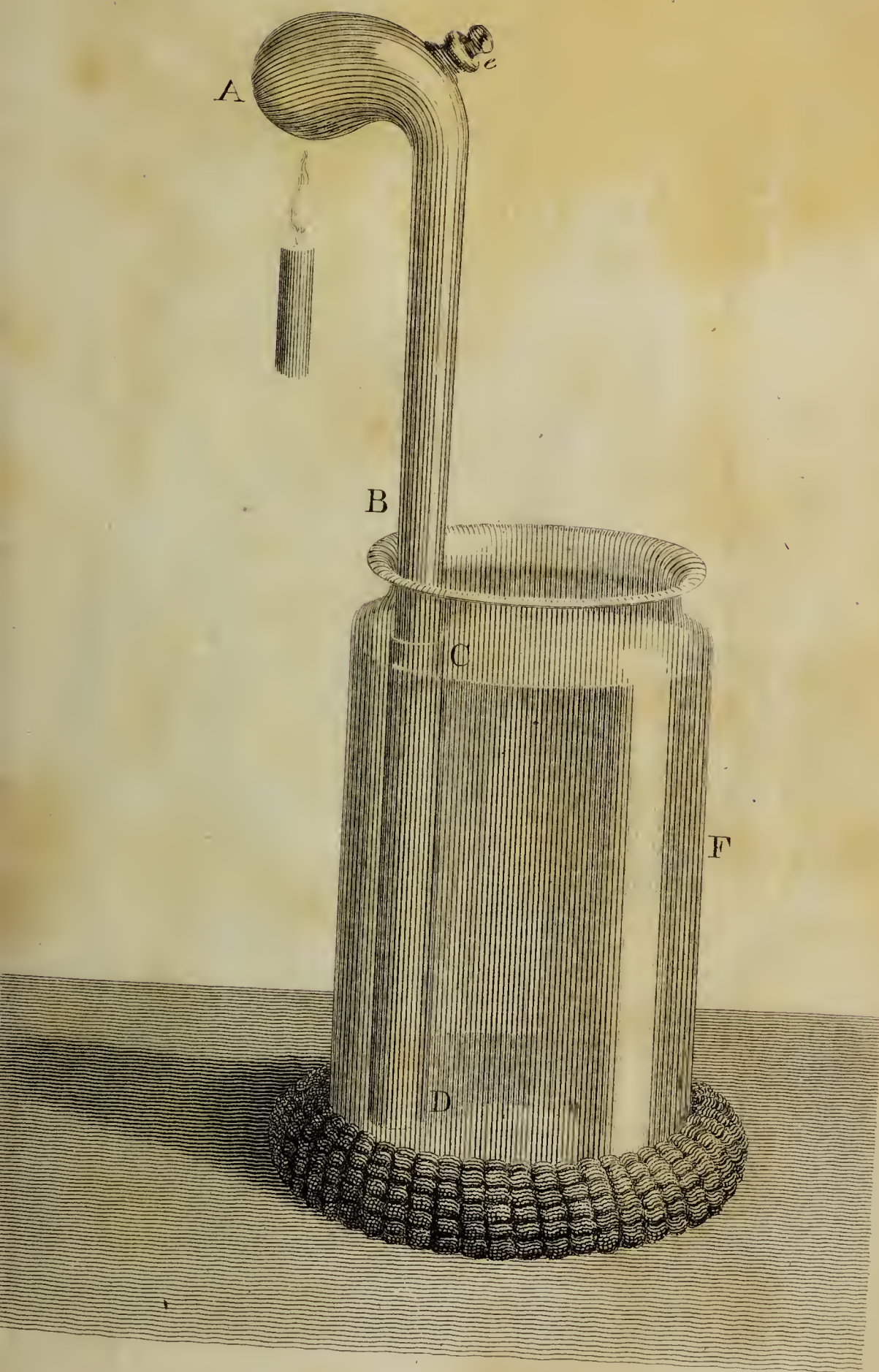


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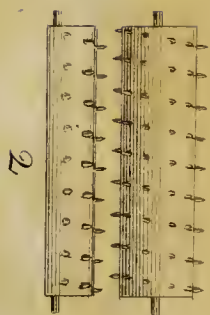
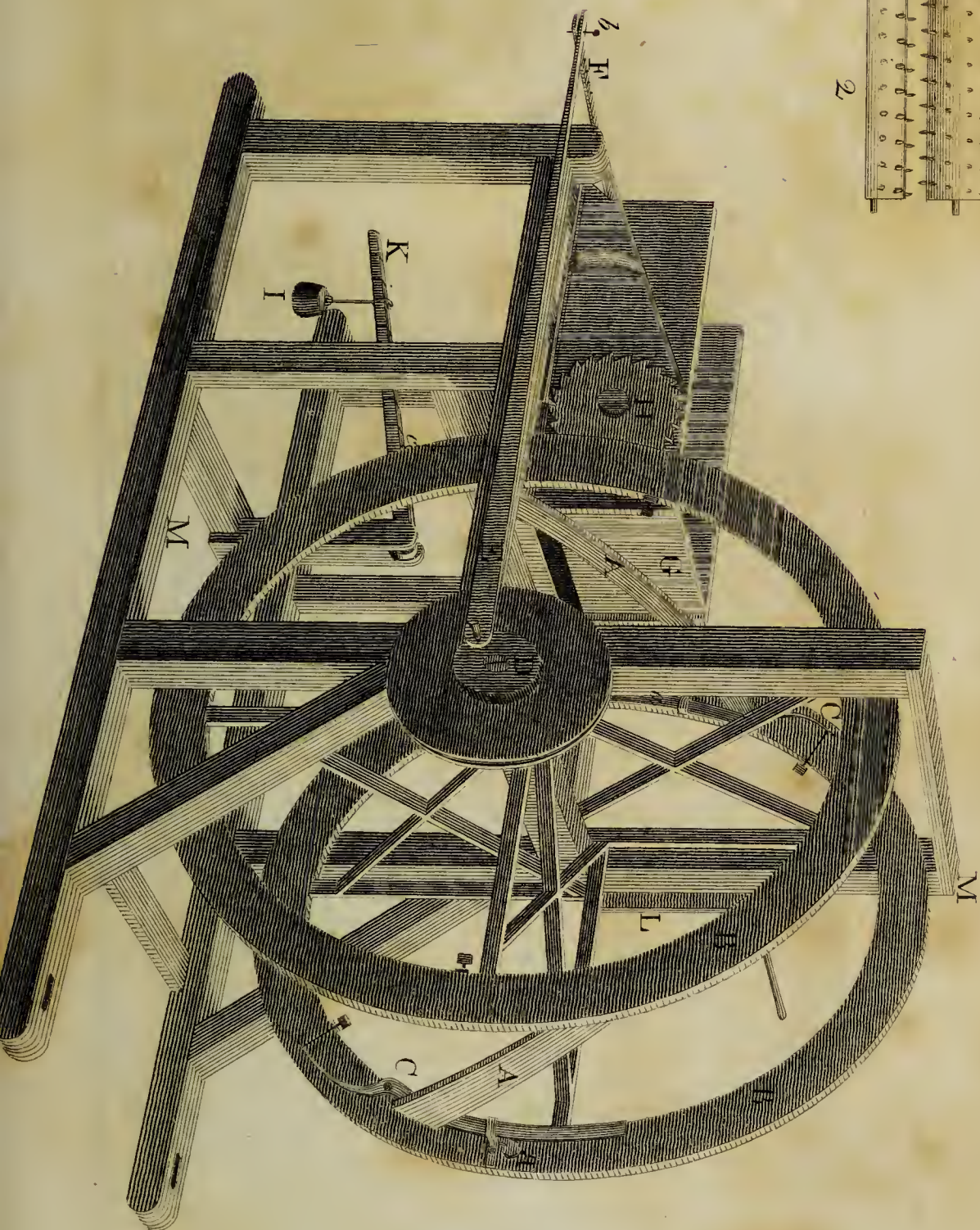


Fig. 1.



Fig. 5.



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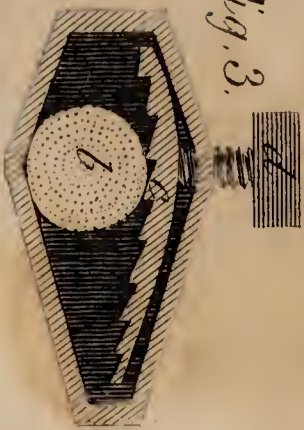
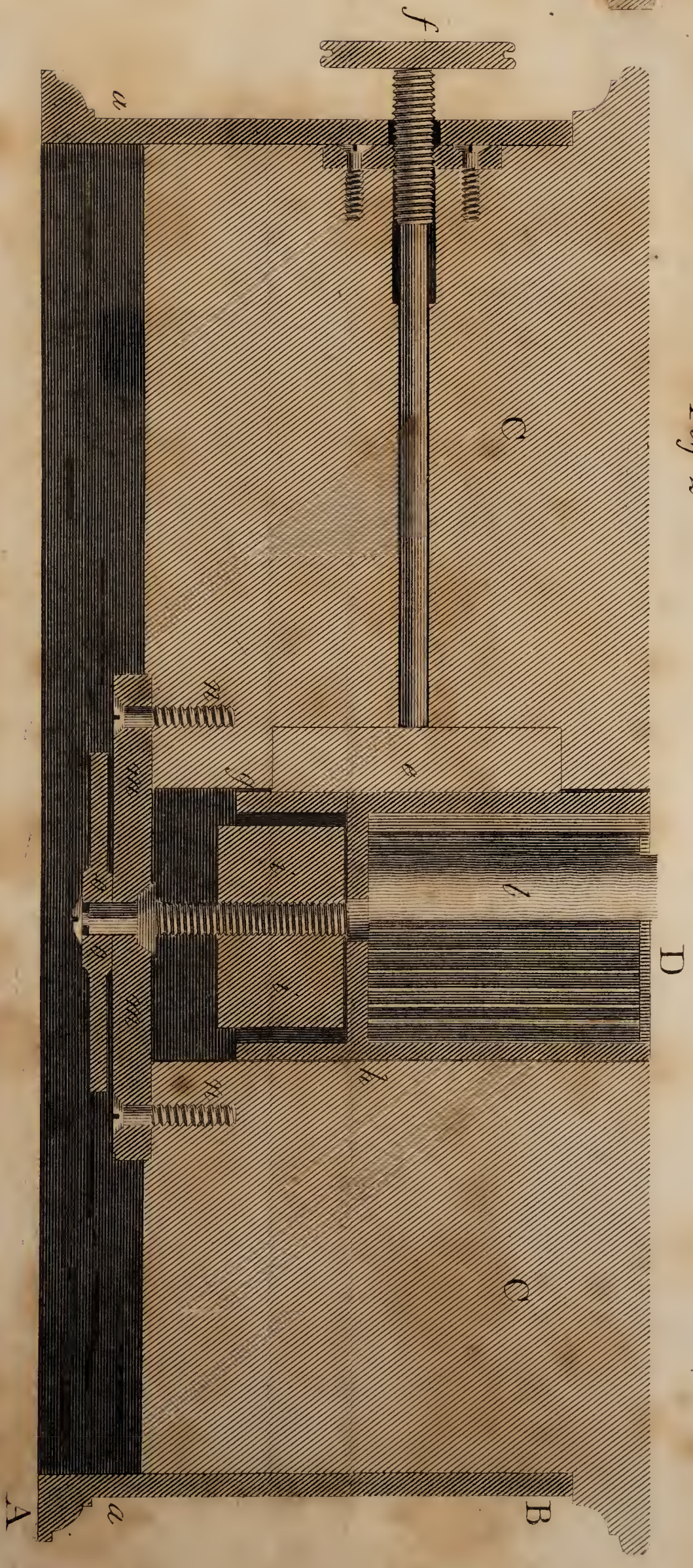


Fig. 4.



Fig. 2.



Engraving Del. & Sculp.



Fig. 2.

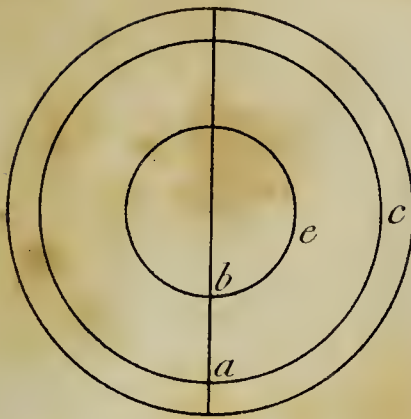


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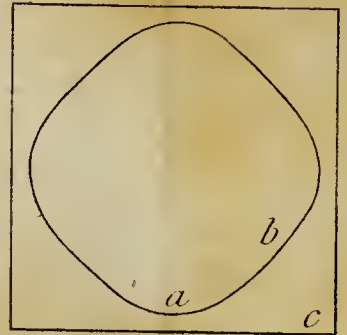


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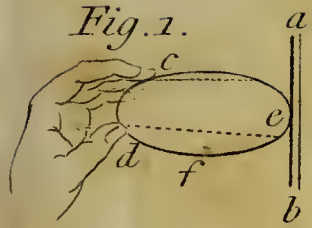


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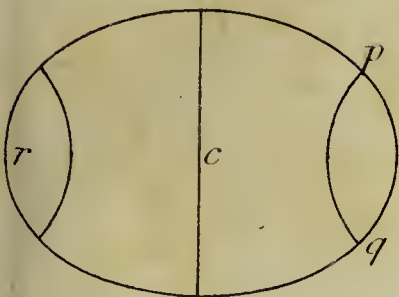


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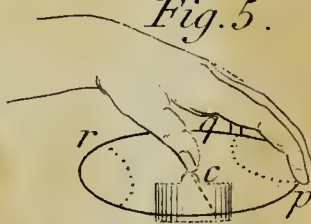


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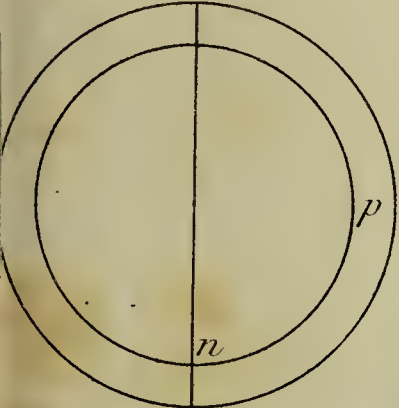


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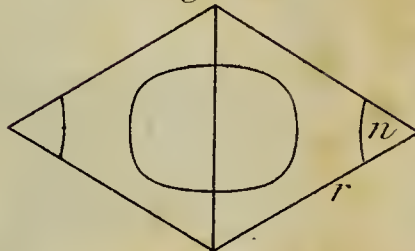


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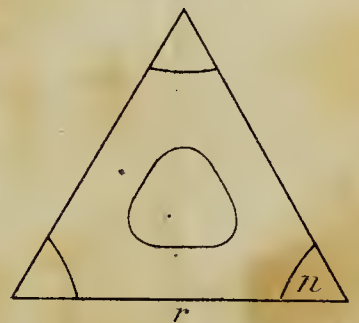


Fig. 10.

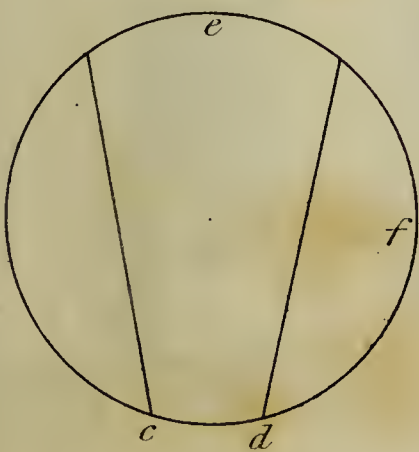
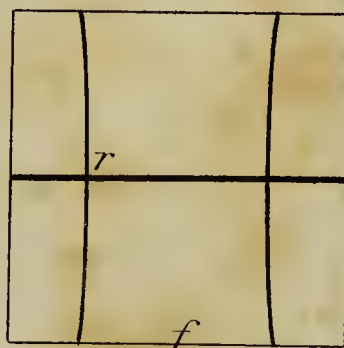
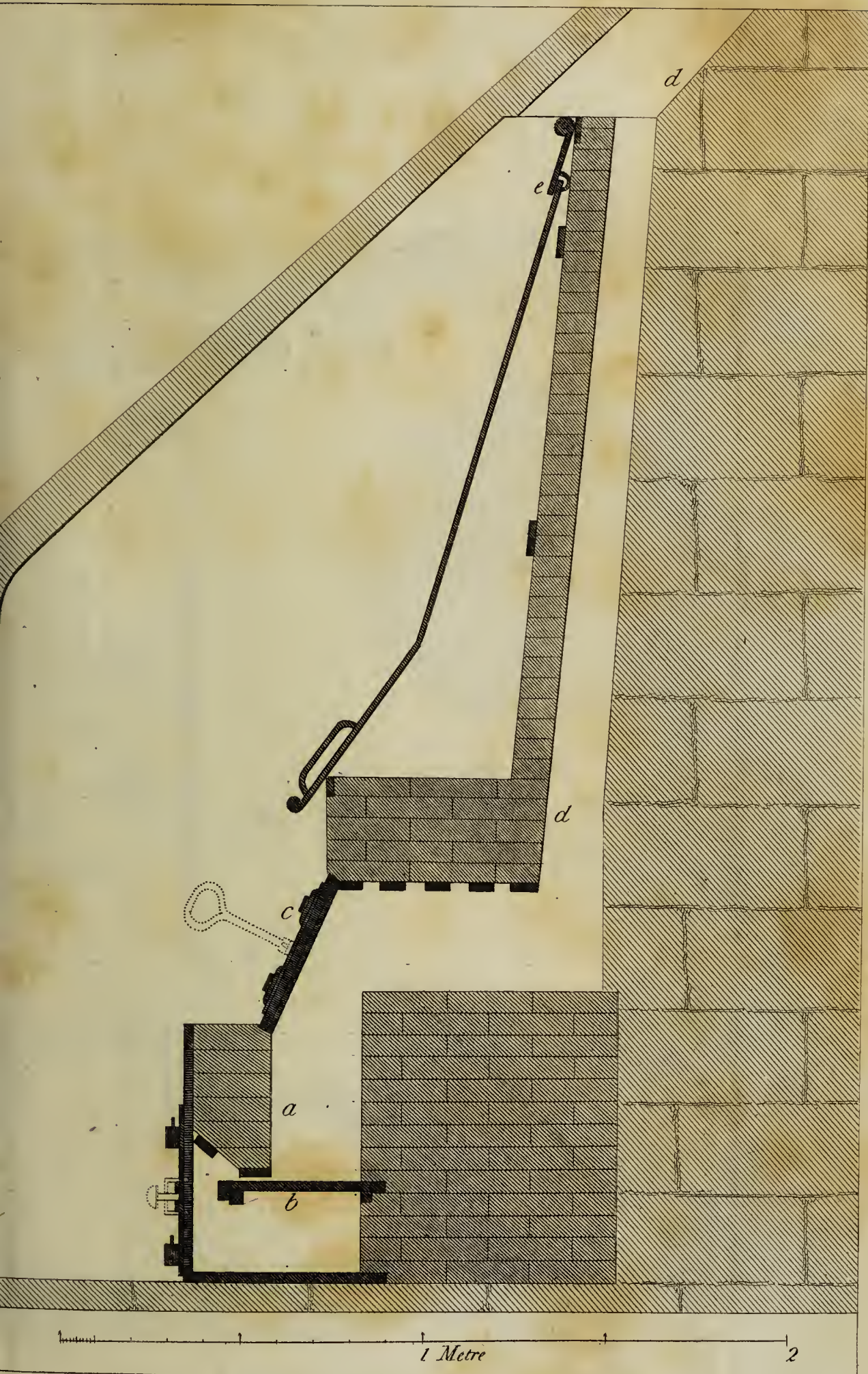
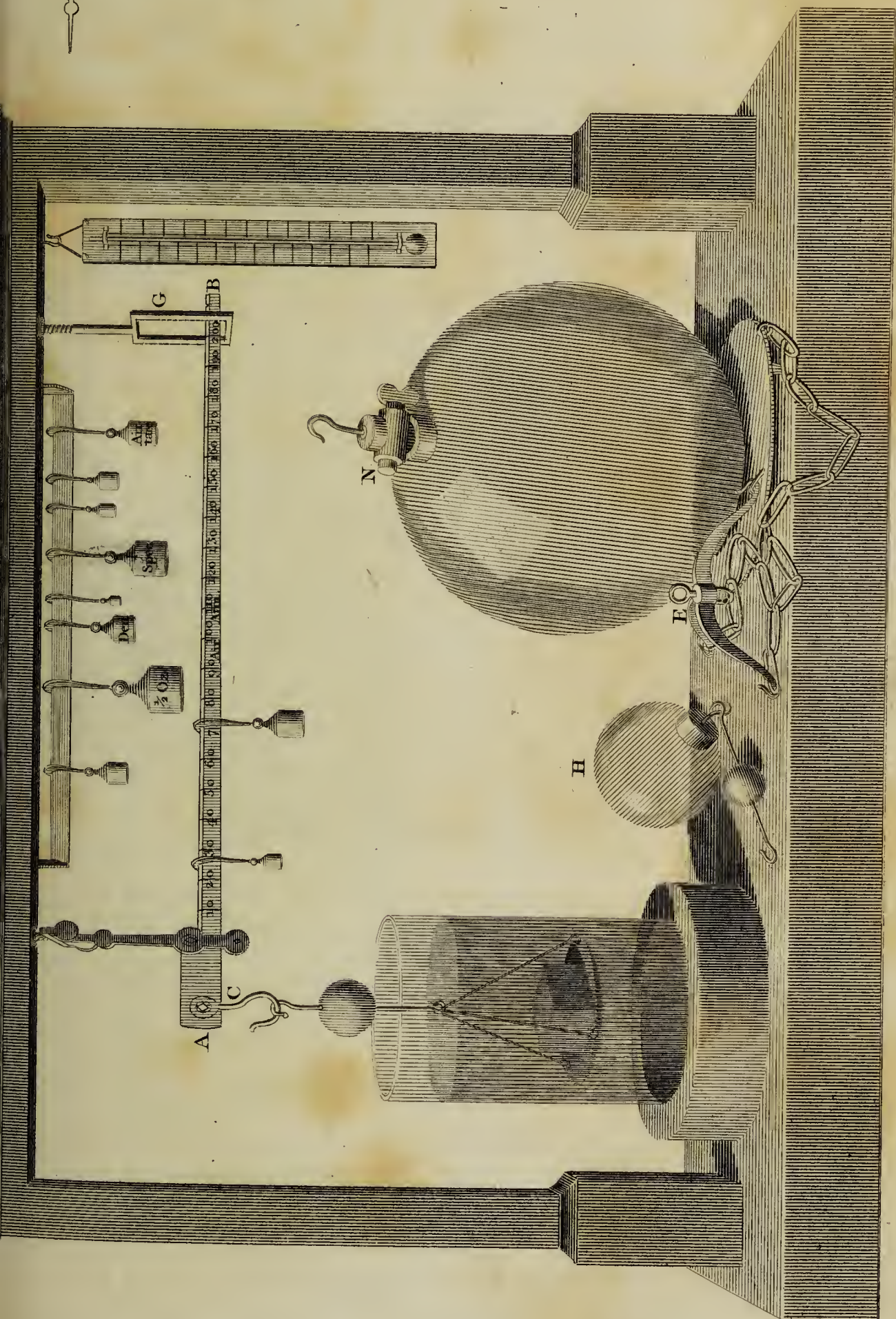
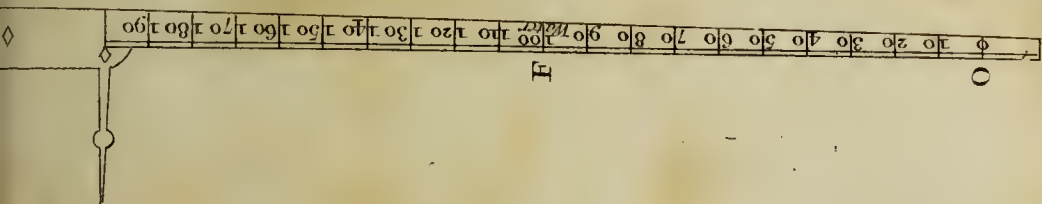


Fig. 11.











Mackenzie sc.

Roger Joseph Boscovich